(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 961 430 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.12.1999 Bulletin 1999/48

(51) Int Cl.[6]: **H04H 1/00**

(21) Application number: **99304152.4**

(22) Date of filing: **27.05.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **29.05.1998 JP 14860998**

(71) Applicant: **SONY CORPORATION**
Tokyo (JP)

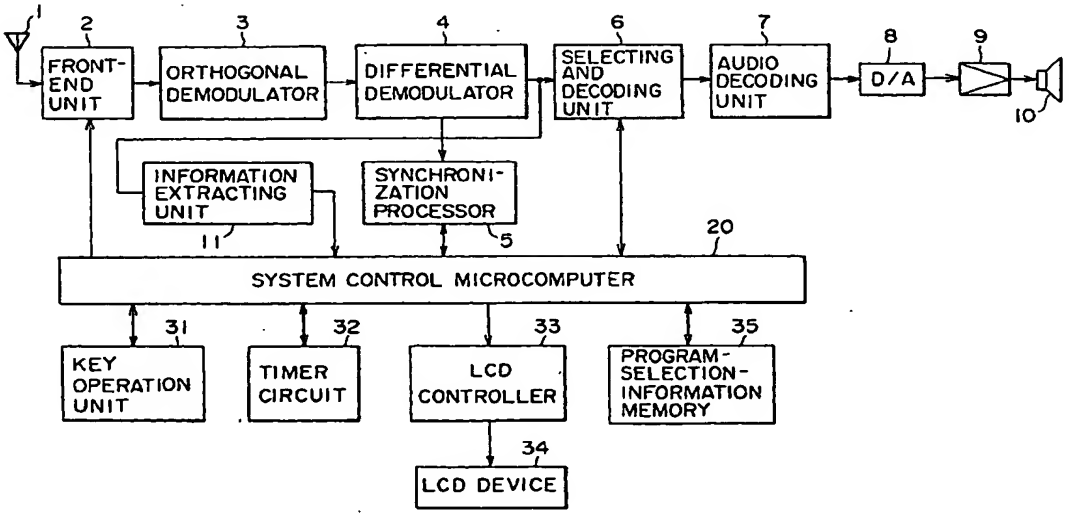
(72) Inventor: **Kimoto, Masashi**
Shinagawa-ku, Tokyo (JP)

(74) Representative: **Ayers, Martyn Lewis Stanley**
J.A. KEMP & CO.
14 South Square
Gray's Inn
London WC1R 5LX (GB)

(54) Receiver for receiving Digital Audio Broadcast (DAB) programmes, comprising automatic selection of broadcast programmes from a plurality of multiplexed programmes

(57) The present invention provides a digital-audio-broadcast receiver capable of extracting any arbitrary one of a plurality of broadcast programs multiplexed in a digital-audio-broadcast ensemble signal selectively received by the receiver with ease. The digital-audio-broadcast receiver comprises: a tuner for selectively receiving a digital-audio-broadcast ensemble signal conveying a plurality of broadcast programs multiplexed therein and additional identification information revealing contents of each of the broadcast programs; a program-selection-information storage unit for storing program-selection information suggesting a broadcast program to be selected on a priority basis from the broadcast programs multiplexed in the digital-audio-broadcast ensemble signal; and a program selecting unit for extracting a broadcast program from the digital-audio-broadcast ensemble signal selectively received by the tuner in accordance with the program-selection information stored in the program-selection-information storage unit and the additional identification information conveyed by the digital-audio-broadcast ensemble signal.

FIG. 1



EP 0 961 430 A2

Description

[0001] The present invention relates to a receiver for receiving digital audio broadcasts.

[0002] In recent years, audio broadcasts have become digital more extensively. In Europe, a DAB (Digital Audio Broadcast) based on European standards called Eureka 147 has been proposed.

[0003] This digital-audio-broadcast (DAB) system is capable of presenting audio information at a high sound quality without losing the quality of the audio information. In addition, this DAB system is also capable of presenting a broadcast with a high added value. To be more specific, a plurality of broadcast programs can be presented by using one ensemble signal which is obtained by multiplexing audio data of a plurality of broadcast programs with additional data in one broadcast wave.

[0004] For example, it is possible to generate an ensemble signal conveying a variety of multiplexed broadcast programs such as news, traffic information, sport events, popular music and classical music. The ensemble signal also includes other data such as information on multiplexing and information on identifications. The information on multiplexing indicates how the broadcast programs were multiplexed. On the other hand, the information on identifications is used for identifying the multiplexed broadcast programs. A receiver for the DAB system is used for receiving an ensemble signal and allows the user to select a desired broadcast program from the programs multiplexed in the ensemble signal and listen to the selected program.

[0005] By the way, in the case of the DAB system, a plurality of ensemble signals each conveying a plurality of multiplexed broadcast programs are broadcasted as described above. It is thus necessary to first selectively receive a desired ensemble signal and then to select a desired broadcast program among those conveyed by the selectively received ensemble signal.

[0006] For this reason, in a receiver for the DAB system, information including that for identifying multiplexed broadcast programs conveyed in a selectively received ensemble signal is used to make a list of broadcast programs multiplexed in the ensemble signal. The list is displayed on a display unit such as an LCD (Liquid Crystal Display) device to be viewed by the user. An input to select a desired broadcast program among those on the list is then entered by the user to the receiver.

[0007] Since the user has to select a desired broadcast program among an extremely large number of broadcast programs multiplexed in an ensemble signal, however, an operation to select a broadcast program is complicated. Much time and much labor may be required till a desired broadcast program is selected. Particularly in the case of a receiver for the DAB system mounted on an automobile, it is dangerous to carry out an operation to select a broadcast program while viewing a list of broadcast programs displayed on a display device of the receiver.

[0008] It would be desirable to provide a receiver for the DAB system addressing the problems described above and which allows the user to select a desired broadcast program and to listen to the selected broadcast program without carrying out a difficult operation.

[0009] In a digital-audio-broadcast receiver provided by the present invention, a digital-audio-broadcast (DAB) signal conveying a plurality of multiplexed broadcast programs and additional identification information showing contents of each of the broadcast programs is selectively received by a tuner and supplied to a program selecting unit.

[0010] The program selecting unit extracts a broadcast program which is selected among those multiplexed in the DAB ensemble signal selectively received by the tuner by using program-selection information stored in a program-selection-information storage unit and the identification information added to the DAB ensemble signal. The program-selection information represents categories of broadcast programs to be selected on a priority basis. A broadcast program of a selected category is extracted, played back and presented to the user by the receiver.

[0011] As a result, the user is capable of listening to a broadcast program which is automatically selected on a priority basis among those multiplexed in the DAB ensemble signal selectively received by the tuner by using program-selection information stored in the program-selection-information storage unit. It is thus no longer necessary for the user to carry out a complicated operation to select a broadcast program among those multiplexed in a DAB ensemble signal.

[0012] In the digital-audio-broadcast receiver provided by the present invention, the program-selection information stored in the program-selection-information storage unit is pairs each comprising a geographical condition and a list of broadcast-program categories to be selected on a priority basis for the geographical condition. Examples of broadcast-program categories are an urban area, a suburb, a mountain or a seashore. In addition, a geographical-information storage unit is used for storing geographical information representing pairs each comprising a position and a geographical condition associated with the position.

[0013] Information on the position of a broadcast station transmitting a DAB ensemble signal added to a DAB ensemble signal selectively received by the tuner is extracted by a positional-information detecting means. The information on a position extracted by the positional-information detecting means is used by a reception-position detecting means for identifying the position of the user listening to the DAB ensemble signal selectively received by the tuner. The position of the user identified by the reception-position detecting means is used by a geographical-condition detecting means for identifying the geographical condition of an area surrounding the position of the user stored in the geographical-information storage unit.

[0014] The geographical condition of an area surrounding the position of the user identified by the geographical-condition detecting means is used by the program selecting unit to select a pair of the program-selection information including the identified geographical condition and a broadcast-program category extracted from the list on a priority basis for the geographical condition stored in the program-selection-information storage unit. The selected pair of the program-selection information and the identification information included in the DAB ensemble signal selectively received by the tuner are used for automatically selecting a broadcast program to be listened to by the user. The selected broadcast program is suitable for the geographical condition of an area surrounding the position of the user.

[0015] As a result, the user is capable of listening to an automatically selected broadcast program that is suitable for the geographical condition of an area surrounding the position of the user. For example, the user is capable of listening to traffic information, popular music or classical music when the user is in an urban area, in a suburb or on a mountain respectively.

[0016] As an alternative, in the digital-audio-broadcast receiver provided by the present invention, the program-selection information stored in the program-selection-information storage unit can also be pairs each comprising a period of time and a list of broadcast-program categories to be selected on a priority basis for the period of time. Examples of the period of time are the AM, the PM and a period between 00:00 AM and 00:00 PM where notation 00:00 represents a point of time.

[0017] A present-time detecting means determines a present time at which a DAB ensemble signal is being selectively received by the tuner. A pair of the program-selection information corresponding to the present time and a broadcast-program category extracted from the list on a priority basis for the present time is read out from the program-selection-information storage unit to be used in conjunction with identification information conveyed by the DAB ensemble signal selectively received by the tuner to extract a broadcast program among those multiplexed in the DAB ensemble signal.

[0018] As a result, without carrying out a complicated operation, the user is capable of listening to an automatically selected broadcast program that is suitable for a period of time during which a DAB ensemble signal is received. For example, the user is capable of listening to traffic information, popular music or classical music at commutation times, in the afternoon or at home respectively.

[0019] As another alternative, in the digital-audio-broadcast receiver provided by the present invention, the program-selection information stored in the program-selection-information storage unit can also be pairs each comprising a combination of information on a geographical condition and information on a period of time, and a list of broadcast-program categories to be selected on a priority basis for the information combination. For example, a news program or a musical program of typically classical music is selected for an urban area in the morning or for an urban area in the afternoon respectively. The geographical information stored in the geographical-information storage unit is pairs each comprising a position and a geographical condition associated with the position.

[0020] Information on the position of a broadcast station transmitting a DAB ensemble signal added to a DAB ensemble signal selectively received by the tuner is detected by a positional-information detecting means. The information on a position detected by the positional-information detecting means is used by a reception-position detecting means for identifying the position of the user listening to the DAB ensemble signal selectively received by the tuner. The position of the user identified by the reception-position detecting means is used by a geographical-condition detecting means for identifying the geographical condition of an area surrounding the position of the user stored in the geographical-information storage unit. In addition, the present-time detecting means determines a present time at which a DAB ensemble signal is being selectively received by the tuner.

[0021] The geographical condition of an area surrounding the position of the user identified by the geographical-condition detecting means and the present time identified by the present-time detecting means are used by the program selecting unit to select a pair including a combination comprising the identified geographical condition and the identified present time and a broadcast-program category extracted from the list on a priority basis for the combination among pairs of the program-selection information stored in the program-selection-information storage unit. The selected pair of the program-selection information and the identification information included in the DAB ensemble signal selectively received by the tuner are used for automatically selecting a broadcast program to be listened to by the user. The selected broadcast program is suitable for the geographical condition of an area surrounding the position of the user and the period of time during which the DAB ensemble signal is received.

[0022] Assume that the user is listening to a broadcast program in an urban area in the morning. In this case, a news program is automatically selected. If the user listens to a broadcast program in an urban area in the afternoon, on the other hand, a program of classical music is automatically selected. That is to say, the DAB receiver is capable of automatically selecting a broadcast program suitable for the geographical condition of an area surrounding the position of the user and the period of time during which the DAB ensemble signal is received.

[0023] The DAB receiver provided by the present invention receives the same DAB ensemble signals from a plurality of transmitting stations at the same time. Even if the DAB ensemble signals use carriers having the same frequency, timing with which the DAB receiver re-

ceives the DAB ensemble signals varies from station to station. Differences in phase among DAB ensemble signals transmitted by different broadcast stations are detected by a phase-shift detecting means.

[0024] Differences in phase among DAB ensemble signals transmitted by a plurality of broadcast stations detected by the phase-shift detecting means and the locations of the transmitting stations are used by the reception-position detecting means for finding the position of the DAB receiver.

[0025] As a result, the position of the DAB receiver can be found with a high degree of accuracy. The accurate position is then used for correctly determining the geographical condition of an area surrounding the position. The correct geographical condition is then used for selecting one of a plurality of broadcast programs multiplexed in the DAB ensemble signal in the same way as described above.

[0026] The present invention will become more apparent from the following detailed description of some preferred embodiments implementing a digital-audio-broadcast (DAB) receiver according to the present invention given by way of non-limitative example with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram used for explaining an embodiment implementing a digital-audio-broadcast (DAB) receiver provided by the present invention;
Fig. 2 is an explanatory diagram showing a frame structure of a DAB ensemble signal conforming to the European standards called Eureka 147;
Fig. 3 is an explanatory diagram used for describing a DAB ensemble signal conveying audio data of a plurality of multiplexed broadcast programs;
Fig. 4 is an explanatory diagram used for describing typical program-selection information stored in a program-selection-information memory employed in the receiver shown in Fig. 1;
Fig. 5 is an explanatory flowchart used for explaining automatic program-selection processing to automatically select a broadcast program from a DAB ensemble signal selectively received by the receiver by using program-selection information stored in the program-selection-information memory;
Fig. 6 is an explanatory diagram used for describing other typical program-selection information stored in the program-selection-information memory employed in the receiver shown in Fig. 1;
Fig. 7 is an explanatory flowchart used for describing automatic program-selection processing to automatically select a broadcast program from a DAB ensemble signal selectively received by the receiver in accordance with program-selection information stored in the program-selection-information memory with reception times taken into consideration;
Fig. 8 is a block diagram used for explaining another embodiment implementing a DAB receiver provided by the present invention;
Fig. 9 is an explanatory diagram used for describing a geographical-information memory employed in the receiver shown in Fig. 8;
Fig. 10 is an explanatory diagram used for describing a program-selection-information memory employed in the receiver shown in Fig. 8;
Fig. 11 is an explanatory flowchart used for describing automatic program-selection processing to automatically select a broadcast program from a DAB ensemble signal selectively received by the receiver shown in Fig. 8 in accordance with a geographical condition of an area surrounding the position of the receiver;
Fig. 12 is an explanatory diagram used for describing a program-selection data base stored in a program-selection-information memory whereby a broadcast program is selected from a DAB ensemble signal selectively received by the receiver in accordance with a geographical condition of an area surrounding the position of the receiver and a reception time on a priority basis;
Fig. 13 is an explanatory flowchart used for describing automatic program-selection processing carried out by the receiver shown in Fig. 8;
Fig. 14 is an explanatory flowchart used for describing automatic program-selection processing carried out by the receiver shown in Fig. 8 wherein a broadcast program is selected from a DAB ensemble signal selectively received by the receiver in accordance with a geographical condition of an area surrounding the position of the receiver and a reception time;
Fig. 15 is an explanatory flowchart used for describing processing to change program-selection information stored in the program-selection-information memory employed in the receiver shown in Fig. 1 or 8;
Fig. 16 is an explanatory flowchart used for describing program-selection processing carried out by a receiver having automatic and manual program-selection modes; and
Fig. 17 is an explanatory diagram used for describing a relation between locations of DAB transmitting stations and the position of a receiver.

[0027] The embodiments described below implement a DAB receiver mounted on a vehicle and used for receiving DABs conforming to the European standards known as Eureka 147. The elements of the different embodiments may be freely combined.

First Embodiment

[0028] Fig. 1 is a block diagram showing a DAB receiver implemented by a first embodiment. The DAB receiver is referred to hereafter simply as a receiver in some cases. Figs. 2 and 3 are explanatory diagrams

used for describing a DAB ensemble signal received by the receiver implemented by the embodiment. First of all, before the receiver implemented by the embodiment is explained, an overview of the DAB system is explained by referring to Figs. 2 and 3.

[0029] A DAB system transmits a DAB ensemble signal which is formed by multiplexing audio data of a plurality of broadcast programs and additional data in a broadcast signal. Audio data of broadcast programs and other data multiplexed in the ensemble signal are subjected to a high-efficiency encoding process or data compression by using layer II of the MPEG audio, an international standard. The data is then subjected to a transmission encoding process using an error correction convolution encoding technique.

[0030] In addition, in the case of the DAB system, the encoded bitstream is interleaved and then subjected to OFDM (Orthogonal Frequency Division Multiplex Modulation) prior to transmission.

[0031] Fig. 2 is an explanatory diagram used for describing a frame structure of a DAB ensemble signal and Fig. 3 is an explanatory diagram used for describing a DAB ensemble signal in which pieces of audio data of a plurality of broadcast programs are multiplexed. A DAB ensemble signal is transmitted in frame units which each comprise synchronization symbols, an FIC (First Information Channel) and an MSC (Main Service Channel) as shown in Fig. 2.

[0032] As described above, a frame includes 2 synchronization symbols. One of them is a null symbol including information for identifying a broadcast station transmitting the DAB ensemble signal.

[0033] Composed of 3 symbols, the FIC includes various kinds of information such as information on multiplexing, information on program categories and latitude/longitude information. The information on multiplexing indicates what data is multiplexed and how data is multiplexed. The information on program categories is information for identifying what broadcast programs are multiplexed, that is, whether each of the multiplexed broadcast programs is news, a weather forecast, sport, popular music or another kind of program. The latitude/longitude information is information on the locations of transmitting stations. The latitude/longitude information corresponds to TII (Transmitting-station Identification Information).

[0034] As shown in Fig. 2, the MSC has data fields of broadcast programs multiplexed along the time axis. That is to say, a plurality of pieces of audio and other data multiplexed in the DAB ensemble signal are placed in the data fields.

[0035] Thus, pieces of audio data of a plurality of broadcast programs are multiplexed in the MSC. The broadcast programs have different categories such as news, sport, popular music, classical music and rock music as shown in Fig. 3.

[0036] The information on program categories and other information are included in the FIC of each frame of the ensemble signal shown in Fig. 2 as described earlier. Thus, by using information on program categories and information on multiplexing included in the FIC, a DAB receiver is capable of extracting audio data of a desired broadcast program from the ensemble signal in which pieces of audio data of a plurality of broadcast programs are multiplexed, playing back the extracted audio data and presenting the reproduced data to the user.

[0037] The following is a description of a DAB receiver implemented by the first embodiment for receiving a DAB ensemble signal in which pieces of audio data of a plurality of broadcast programs are multiplexed with reference to Fig. 1.

[0038] As shown in Fig. 1, the receiver implemented by the first embodiment comprises an antenna 1, a front-end unit (tuner) 2, an orthogonal demodulator 3, a differential demodulator 4, a synchronization processor 5, a selecting and decoding unit 6, an audio decoding unit 7, a D/A-conversion unit 8, an amplifier circuit 9, a speaker 10, an information extracting unit 11, a system-control microcomputer 20, a key operation unit 31, a timer circuit 32, an LCD controller 33, an LCD device 34 and a program-selection-information memory 35.

[0039] The system control microcomputer 20 includes a CPU, a ROM unit, a RAM unit and a nonvolatile memory which are not shown in the figure. The system control microcomputer 20 controls other components employed in the receiver implemented by this embodiment. The key operation unit 31 has a variety of operation keys and buttons such as a power-supply-on/off key, a key for entering information for selecting a broadcast station and a volume adjusting key. The user of the receiver implemented by this embodiment enters a command via the key operation unit 31. Information representing a command entered by the user via the key operation unit 31 is supplied to the system control microcomputer 20 which then controls other components employed in the receiver in accordance with the information.

[0040] Provided with a calendar function, the timer circuit 32 is capable of presenting the present time and controlling days of the week and dates. Controlled by the system control microcomputer 20, the LCD controller 33 displays information such as a plurality of guidance messages on the LCD device 34. As will also be described later, the LCD controller 33 is capable of displaying various kinds of information such as the frequency of a selected broadcast station and the present time which need to be reported to the user of the receiver on the LCD device 34.

[0041] The program-selection-information memory 35 employed in the receiver implemented by this embodiment is a nonvolatile memory for storing program-selection information used for indicating a broadcast program to be selected on a priority basis among a plurality of broadcast programs multiplexed in a selected DAB ensemble signal. The receiver implemented by this embodiment is capable of automatically receiving a

broadcast program indicated by the program-selection information stored in the program-selection-information memory 35 as a broadcast program pertaining to a category selected on a priority basis, playing back the selected broadcast program and presenting the reproduced program to the user. In this way, the program-selection-information memory 35 is used as a program-selection-information storage unit.

[0042] DAB ensemble signals caught by the antenna 1 are supplied to the front-end unit 2 which then selects a desired one of the DAB ensemble signals indicated by a command to select a broadcast station received from the system control microcomputer 20. Subsequently, the selected DAB ensemble signal is converted into a signal having an intermediate frequency which is then supplied to the orthogonal demodulator 3.

[0043] The orthogonal demodulator 3 demodulates the intermediate-frequency signal to generate I-component and Q-component signals of a base-band signal which is then supplied to the differential demodulator 4. The differential demodulator 4 is designed as an FFT (Fast Fourier Transformation) circuit. In this case, a base-band signal which has been converted into a digital signal is supplied to the differential demodulator 4. The differential modulator 4 then carries out OFDM modulation on the I-component and Q-component signals. A DAB ensemble signal obtained as a result of the demodulation processes is then supplied to the selecting and decoding unit 6 and the information extracting unit 11.

[0044] The synchronization processor 5 is implemented by a DSP (Digital Signal Processor). The synchronization processor 5 carries out processing such as computation of a frequency offset of an input signal received from the differential demodulator 4 to generate an AFC (Automatic Frequency Control) signal. In addition, the synchronization processor 5 also finds an impulse response of a transmission line to generate a CIR (Channel Impulse Response) signal as an output.

[0045] The information extracting unit 11 extracts information on multiplexing of audio data and other necessary information such as categories of multiplexed broadcast programs from the FIC of each frame of the demodulated DAB ensemble signal, supplying the extracted information to the system control microcomputer 20.

[0046] The selecting and decoding unit 6 carries out deinterleaving and error correction to generate the original DAB ensemble signal. Then, the selecting and decoding unit 6 receives program-selection information stored in the program-selection-information memory 35 from the system control microcomputer 20. Subsequently, the selecting and decoding unit 6 selects one of a plurality of broadcast programs multiplexed in the DAB ensemble signal in accordance with the program-selection information and the program categories or program identifications extracted from the IFC of each frame, and extracts the audio data of the selected broadcast program from the ensemble signal, outputting the extracted data to the audio decoding unit 7.

[0047] Fig. 4 is an explanatory diagram showing typical program-selection information stored in the program-selection-information memory 35 employed in the receiver implemented by this embodiment. As shown in the figure, the program-selection information stored in the program-selection-information memory 35 employed in the receiver implemented by this embodiment is pairs each comprising a priority level and a category of a broadcast program to be selected at the priority level.

[0048] As shown in Fig. 4, typical categories of broadcast programs of the program-selection information stored in the program-selection-information memory 35 are news, classical music, popular music and so on which are listed in an order of decreasing priority levels. In this case, the system control microcomputer 20 reads out the first-priority pair of the program-selection information from the program-selection-information memory 35. The category in the pair of the program-selection information suggests the selecting and decoding unit 6 to select a broadcast program of the news category which has the highest priority level.

[0049] The system control microcomputer 20 then checks whether or not a news program is included in the selected ensemble signal by referring to information extracted from the FICs and supplied thereto by the information extracting unit 11. If a news program is included, the system control microcomputer 20 supplies the category of a broadcast program in the pair of the program-selection information to the selecting and decoding unit 6 to request that the news program be selected. The selecting and decoding unit 6 selects one of a plurality of broadcast programs multiplexed in the DAB ensemble signal in accordance with the category in the pair of the program-selection information received from the system control microcomputer 20, and extracts the audio data of the selected broadcast program from the ensemble signal, outputting the extracted data to the audio decoding unit 7.

[0050] If a news program is not included in the selected ensemble signal, on the other hand, the system control microcomputer 20 reads out a pair of the program-selection information at the next priority level from the program-selection-information memory 35. The pair of the program-selection information read out from the program-selection-information memory 35 in this case suggests the selecting and decoding unit 6 to select a broadcast program of the classical-music category which has the second highest priority level. The system control microcomputer 20 then checks whether or not a classical-music program is included in the selected ensemble signal by referring to information extracted from the FICs and supplied thereto by the information extracting unit 11. If a classical-music program is included, the system control microcomputer 20 supplies the category in the second pair of the program-selection information

to the selecting and decoding unit 6 to request that the classical-music program be selected.

[0051] In this way, the system control microcomputer 20 supplies a category of a broadcast program included in the program-selection information stored in the program-selection-information memory 35 to the selecting and decoding unit 6. Then, the selecting and decoding unit 6 selects one of a plurality of broadcast programs multiplexed in the DAB ensemble signal in accordance with the category supplied thereto by the system control microcomputer 20, and extracts the audio data of the selected broadcast program from the ensemble signal, outputting the extracted data to the audio decoding unit 7. That is to say, the selecting and decoding unit 6 functions as a program selecting unit.

[0052] The audio decoding unit 7 decompresses audio data which was compressed by using the MPEG audio system and multiplexed in the ensemble signal, supplying the decompressed data to the D/A-conversion unit 8. The D/A-conversion unit 8 converts the digital audio data supplied thereto into an analog signal which is then supplied to the speaker 10 by way of the amplifier circuit 9. As a result, the audio signal of a broadcast program suggested by a category selected on a priority basis from the program-selection information stored in the program-selection-information memory 35 is played back and output through the speaker 10.

[0053] Fig. 5 is a flowchart representing automatic program selection processing carried out by the receiver implemented by the first embodiment to automatically select a broadcast program from a DAB ensemble signal selectively accepted by the front-end unit 2 on the basis of program-selection information stored in the program-selection-information memory 35.

[0054] The processing represented by the flowchart shown in Fig. 5 is carried out by the system control microcomputer 20 typically when the power supply of the receiver implemented by the first embodiment is turned on to start reception of a DAB ensemble signal or when the front-end unit 2 is operated to change a selected DAB ensemble signal.

[0055] As shown in Fig. 5, the flowchart begins with a step S101 at which the system control microcomputer 20 reads out a piece of program-selection information with the highest priority from the program-selection-information memory 35. The flow of the processing then goes on to a step S102 to form a judgment as to whether or not audio data of a broadcast program with a category indicated by the piece of program-selection information read out from the program-selection-information memory 35 is included in the selected DAB ensemble signal.

[0056] If the outcome of the judgment formed at the step S102 indicates that audio data of a broadcast program with a category indicated by the piece of program-selection information read out from the program-selection-information memory 35 is not included in the selected DAB ensemble signal, the flow of the processing goes on to a step S103 at which the priority of the program-selection information to be read from the program-selection-information memory 35 is lowered. The flow of the processing then goes back to the step S101 to repeat the pieces of processing of the step S101 and S102.

[0057] If the outcome of the judgment formed at the step S102 indicates that audio data of a broadcast program with a category indicated by the piece of program-selection information read out from the program-selection-information memory 35 is included in the selected DAB ensemble signal, on the other hand, the flow of the processing goes on to a step S104 at which the piece of program-selection information read out from the program-selection-information memory 35 is supplied to the selecting and decoding unit 6 and then the automatic program selection processing represented by the flowchart shown in Fig. 5 is ended.

[0058] As described above, a piece of program-selection information stored in the program-selection-information memory 35 in advance and used for selecting the category of a broadcast program on a priority basis is supplied to the selecting and decoding unit 6 which then automatically selects audio data of a desired broadcast program indicated by the program category described in the piece of program-selection information from the ensemble signal. The audio data is then played back and output to the speaker 10.

[0059] As described above, by merely carrying out a simple operation such as pressing the power-supply-on/off key of the DAB receiver implemented by the first embodiment to turn on the power supply and start reception of a DAB ensemble signal or by merely pressing a station selecting key after turning on the power supply to change a broadcast station transmitting a DAB ensemble signal, the user of the DAB receiver implemented by the first embodiment is capable of automatically selecting a broadcast program in accordance with program-selection information stored in the program-selection-information memory 35, having the audio data of the selected broadcast program played back and listening to the reproduced broadcast program without the need to carry out a complicated operation to select the desired broadcast program.

[0060] Thus, when the user drives an automobile with the DAB receiver of the first embodiment mounted thereon, the user is capable of automatically selecting a desired one among a plurality of broadcast programs multiplexed in a DAB ensemble signal received by the DAB receiver as suggested by a program category selected on a priority basis from the program-selection information stored in the program-selection-information memory 35, having the audio data of the selected broadcast program played back and listening to the reproduced broadcast program without the need to carry out a complicated operation to select the desired broadcast program by referring to a list of broadcast programs displayed on the LCD device 34 employed in the DAB receiver.

Second Embodiment

[0061] It is also possible to change a broadcast program automatically selected on a priority basis among a plurality of broadcast programs multiplexed in a DAB ensemble signal in accordance with a reception-time period. In a word, a broadcast program to be selected can be changed in dependence on a reception-time period. A function to change a broadcast program to be selected as such is implemented in a second embodiment. In the second embodiment, program-selection information taking information on reception-time periods into consideration is stored in advance in the program-selection-information memory 35 employed in the DAB receiver shown in the circuit block diagram of Fig. 1.

[0062] Fig. 6 is an explanatory diagram used for describing typical program-selection information stored in advance in the program-selection-information memory 35 by taking information on reception-time periods into consideration. As shown in the figure, the typical program-selection information stored in advance in the program-selection-information memory 35 is pairs each comprising a reception-time period and the program category of a broadcast program to be selected as the first choice during the reception-time period as shown in Fig. 6. In actuality, for each reception-time period, there is provided a list of prioritized broadcast-program categories like the one shown in Fig. 4 to be selected as a first choice, a second choice and so on, on a priority-basis. In Fig. 6, however, only the program category of a broadcast program to be selected as a first choice is shown for each reception-time period.

[0063] As shown in Fig. 6, the program-selection information stored in advance in the program-selection-information memory 35 suggests that traffic information, popular music, news or classical music be selected typically as a first choice for a period of time from 6:00 to 9:00, 9:00 to 17:00, from 17:00 to 19:00 or after 19:00, respectively.

[0064] The configuration of the second embodiment is shown in Fig. 1. As shown in the figure, the DAB receiver implemented by the second embodiment includes the timer circuit 32 which allows the system control microcomputer 20 to recognize the present time just after the power supply of the receiver is turned on or just after a selected broadcast station transmitting a DAB ensemble signal is changed after the power supply has been turned on. Thus, the system control microcomputer 20 functions as a present-time acquiring means to acquire a present time from the timer circuit 32 in this case.

[0065] The system control microcomputer 20 reads out a piece of program-selection information from the program-selection-information memory 35 for an acquired present time, supplying the piece of program-selection information to the selecting and decoding unit 6. If the present time is a commutation time between 7:00 and 9:00, for example, a broadcast program of traffic information multiplexed in a DAB ensemble signal selected by the DAB receiver is automatically extracted as a first choice.

[0066] Similarly, a popular-music, news or classical-music broadcast program is automatically selected as a first choice for a present time in a period of time from 9:00 to 17:00, from 17:00 to 19:00 or after 19:00, respectively.

[0067] Fig. 7 is a flowchart representing automatic program selection processing for selecting a broadcast program from a DAB ensemble signal selectively received by the DAB receiver by using program-selection information which is based on reception-time periods and stored in the program-selection-information memory 35. Like the processing represented by the flowchart shown in Fig. 5, the processing represented by the flowchart shown in Fig. 7 is carried out by the system control microcomputer 20 typically when the power supply of the receiver implemented by the second embodiment is turned on to start reception of a DAB ensemble signal or when the front-end unit 2 is operated to change a selected DAB ensemble signal.

[0068] As shown in Fig. 7, the flowchart begins with a step S201 at which the system control microcomputer 20 acquires a present time from the timer circuit 32. Then, the flow of the processing goes on to a step S202 at which the system control microcomputer 20 reads out a piece of program-selection information from the program-selection-information memory 35 for the acquired present time. The flow of the processing then goes on to a step S203 at which the system control microcomputer 20 searches the FIC of a selected DAB ensemble signal for a broadcast program indicated by a program category described in the piece of particular program-selection information.

[0069] The search of the selected DAB ensemble signal for a broadcast program indicated by the program category described in the piece of particular program-selection information is based on information on multiplexing of data included in the FIC of each frame of the DAB ensemble signal and other necessary information such as the categories of broadcast programs multiplexed in the DAB ensemble signal which are supplied by the information extracting unit 11 to the system computer 20.

[0070] Then, the flow of the processing goes on to a step S204 to form a judgment as to whether or not a broadcast program indicated by the program category described in the piece of program-selection information is included in the DAB ensemble signal. If the outcome of the judgment formed at the step S204 indicates that a broadcast program indicated by the program category described in the piece of program-selection information is not included in the DAB ensemble signal, the flow of the processing goes back to the step S202 to read out another piece of program-selection information from a list of categories for the same time period stored in the program-selection-information memory 35 in a format

like one shown in Fig. 4 as a second choice and then to the step S203 to search the selected DAB ensemble signal for a broadcast program indicated by the program category described in the other piece of program-selection information. It should be noted that pieces of program-selection information are selected as a first choice, a second choice and so on, on a priority basis in the same way as the processing represented by the flowchart shown in Fig. 5. The pieces of processing of the steps S202, S203 and S204 are repeated till a broadcast program indicated by a program category described in a piece of program-selection information is found.

[0071] As the outcome of the judgment formed at the step S204 indicates that a broadcast program indicated by a program category described in a piece of program-selection information is included in the DAB ensemble signal, the flow of the processing goes on to a step S205 at which the piece of program-selection information is supplied to the selecting and decoding unit 6 and then the automatic program selection processing represented by the flowchart shown in Fig. 7 is ended.

[0072] The selecting and decoding unit 6 carries out deinterleaving and error correction to generate the original DAB ensemble signal as described above. The selecting and decoding unit 6 then selects audio data of a desired broadcast program indicated by the program category included in the program-selection information supplied thereto by the system control microcomputer 20 from the ensemble signal and outputs the reproduced data to the audio decoding unit 7.

[0073] The audio decoding unit 7 decompresses audio data compressed by using the MPEG audio system, supplying the decompressed data to the D/A-conversion unit 8. The D/A-conversion unit 8 converts the digital audio data supplied thereto into an analog signal which is then supplied to the speaker 10 by way of the amplifier circuit 9.

[0074] As described above, a broadcast program can be selected automatically on a priority basis for a period of reception time by using program-selection information stored in the program-selection-information memory 35 in advance. Since the broadcast program to be selected varies from period to period, better automatic selection of a broadcast program is possible.

[0075] It should be noted that the user of the receiver implemented by the first and second embodiments is allowed to change the program-selection information stored in the program-selection-information memory 35. A procedure to change the program-selection information will be described later in detail.

[0076] In addition, the receiver implemented by the first and second embodiments displays a list of broadcast programs on the LCD device 34. The list is based on information on multiplexing of data included in the FIC of each frame of a selected DAB ensemble signal and other necessary information such as the categories of broadcast programs multiplexed in the DAB ensemble signal. The user of the receiver implemented by the first and second embodiments is also capable of manually selecting a broadcast program from the list.

[0077] The user of the receiver is capable of choosing the manual selection of a broadcast program or the automatic selection of a broadcast program based on program-selection information stored in the program-selection-information memory 35. Proper use of the manual selection and the automatic selection will be described in detail later.

Third Embodiment

[0078] As described earlier by referring to Fig. 2, the null symbol of each frame of a DAB ensemble signal includes an identification of a plurality of broadcast stations transmitting the DAB ensemble signal. The identification is also referred to as transmitting-station-identification information. In addition, the FIC of each frame of a selected DAB ensemble signal includes information on the positions of the broadcast stations transmitting the DAB ensemble signal that can be received by receivers. Referred to as latitude/longitude information, such information indicates the position of each of the transmitting stations identified by the transmitting-station-identification information in the null symbol.

[0079] Thus, the transmitting-station-identification information included in the null symbol and the information on the position of a transmitting station in the FIC can be used to identify a broadcast station transmitting a DAB ensemble signal selectively received by the receiver. In the case of the DAB system, a plurality of broadcast stations each for transmitting a small-power broadcast signal are laid out to form a broadcasting network. As a result, an approximate position of the receiver can be identified from the position of a broadcast station transmitting a DAB ensemble signal received by the receiver.

[0080] Taking advantage of the ability to identify an approximate position of the receiver, a third embodiment implementing the receiver receiving an DAB ensemble signal recognizes the geographical condition of the position of the receiver and then automatically selects a broadcast program of a category suitable for the geographical condition among those multiplexed in the DAB ensemble signal. For example, news or a classical-music program is selected as a first choice when the position of the receiver is an urban or suburban location respectively.

[0081] Fig. 8 is a block diagram showing a DAB receiver implemented by a third embodiment.

[0082] As shown in Fig. 8, the receiver implemented by the third embodiment comprises an antenna 1, a front-end unit 2, an orthogonal demodulator 3, a differential demodulator 4, a synchronization processor 5, a selecting and decoding unit 6, an audio decoding unit 7, a D/A-conversion unit 8, an amplifier circuit 9, a speaker 10, a transmitting-station-identification-information de-

tecting unit 12, a positional-information detecting unit 13, a system control microcomputer 20, a key operation unit 31, a timer circuit 32, an LCD controller 33, an LCD device 34, a geographical-information memory 36 and a program-selection-information memory 37.

[0083] As described above, the receiver implemented by the third embodiment shown in Fig. 8 has all but the same configuration as the receiver implemented by the first embodiment as explained earlier by referring to Fig. 1 except that, in the case of the former, the transmitting-station-identification-information detecting unit 12, the positional-information detecting unit 13 and the geographical-information memory 36 are newly provided and the program-selection-information memory 37 is different from the program-selection-information memory 35 of the latter. For this reasons, components employed in the receiver implemented in the third embodiment identical with components employed in the receiver implemented in the first embodiment are denoted by the same reference numerals as the latter and their explanation is not repeated.

[0084] In the third embodiment, the transmitting-station-identification-information detecting unit 12 extracts transmitting-station-identification information included in the null symbol of a demodulated DAB ensemble signal selectively received by the receiver and supplies the extracted information to the system control microcomputer 20.

[0085] On the other hand, the positional-information detecting unit 13 extracts information on the position of a broadcast station transmitting a demodulated DAB ensemble signal selectively received by the receiver, information on multiplexing of audio data and other necessary information such as the categories of broadcast programs multiplexed in the DAB ensemble signal from the FIC of each frame of the DAB ensemble signal and supplies the extracted information to the system control microcomputer 20.

[0086] The system control microcomputer 20 determines the latitude/longitude information of the position of a broadcast station transmitting a demodulated DAB ensemble signal selectively received by the receiver implemented by the third embodiment from the transmitting-station-identification information received from the transmitting-station-identification-information detecting unit 12 and the positional information received from the positional-information detecting unit 13. The determined latitude/longitude information of the position of a broadcast station can in turn be used as information on the position of the receiver implemented by the third embodiment.

[0087] In addition, the receiver implemented by the third embodiment is provided with the geographical-information memory 36 and the program-selection-information memory 37 so as to allow a broadcast program suitable to a geographical condition of an area surrounding the position of the receiver to be automatically selected from a demodulated DAB ensemble signal selectively received by the receiver. Both the geographical-information memory 36 and the program-selection-information memory 37 are a nonvolatile memory. Fig. 9 is an explanatory diagram used for describing the geographical-information memory 36 and Fig. 10 is an explanatory diagram used for describing the program-selection-information memory 37.

[0088] As shown in Fig. 9, the geographical-information memory 36 is used for storing a geographical-information data base of pairs each comprising a positional information represented by latitude/longitude data and a geographical condition of an area surrounding the position. In the case of the third embodiment, the latitude/longitude data stored in the geographical-information memory 36 does not merely represent a place but identifies an area to which the position of the receiver receiving DAB ensemble signals as implemented by the third embodiment pertains. The latitude/longitude data is referred to as the so-called area information.

[0089] Thus, each piece of latitude/longitude data stored in the geographical-information memory 36 can be used to identify an area in which the position of the receiver receiving a DAB ensemble signal is included. Typically, the area has a radius of several kilometers and a center coinciding with the position of a broadcast signal transmitting the DAB ensemble signal, or represents a plurality of places with latitudes and longitudes in a predetermined range. The geographical condition associated with a particular piece of latitude/longitude data is information on a geographical condition of the area which is represented by the particular latitude/longitude data.

[0090] In the third embodiment, it is possible to estimate an approximate range of an area in which a receiver is capable of receiving a DAB ensemble signal transmitted by a DAB station from the transmission power of the DAB station. Thus, if the position of a DAB station transmitting a DAB ensemble signal received by a receiver is known, an approximate position of the receiver receiving the DAB ensemble signal transmitted by the DAB station is also known.

[0091] As described above, in the case of the DAB system, a plurality of broadcast stations each for transmitting a small-power broadcast signal are laid out to form a broadcasting network and it is possible to determine a geographical condition of an area, in which the broadcast signal can be received by the receiver, to a certain degree. This is because the third embodiment has a data base stored in the geographical-information memory 36. As shown in Fig. 9, information stored in the data base is pairs each comprising the position of an area of a broadcast station represented by latitude/longitude data of the broadcast station and a geographical condition of an area surrounding the position, that is, a geographical condition of the area in which the receiver is capable of receiving a DAB ensemble signal transmitted by the broadcast station.

[0092] Since the receiver is capable of receiving a

DAB ensemble signal transmitted by the broadcast station in the area, the latitude/longitude data of a broadcast station transmitting a DAB ensemble signal received by the receiver also indicates an area in which the receiver exists presently. That is to say, the geographical condition associated with the latitude/longitude data in the data base stored in the geographical-information memory 36 is therefore the geographical condition of an area surrounding the position of the receiver. Examples of geographical conditions of an area surrounding the present position of the receiver in the third embodiment are an urban area, a suburb, a mountain, a seashore and a plateau as shown in Fig. 9.

[0093] In addition, the third embodiment also has a program-selection data base stored in the program-selection-information memory 37 shown in Fig. 10. As shown in the figure, information stored in the program-selection-information memory 37 is pairs each comprising a geographical condition and the category of a broadcast program to be selected as a first choice for the geographical condition. Thus, if the latitude/longitude information of an area surrounding the position of the receiver is known, the geographical condition of the area surrounding the position can be obtained from the geographical-condition data base stored in the geographical-information memory 36. The geographical condition is then used to find the category of a broadcast program to be selected as a first choice for the position of the receiver from the program-selection data base stored in the program-selection-information memory 37.

[0094] In actuality, for each geographical condition, there is provided a list of prioritized broadcast-program categories like the one shown in Fig. 4 to be selected as a first choice, a second choice and so on, on a priority-basis. In Fig. 10, however, only the category of a broadcast program to be selected as a first choice is shown for each geographical condition.

[0095] By supplying a piece of program-selection information of the program category read out from the program-selection-information memory 37 to the selecting and decoding unit 6, a broadcast program suitable for an area surrounding the position of the receiver can be selected as a first choice, played back and presented to the user as described before.

[0096] The following is a description of processing carried out by the receiver implemented by the third embodiment to automatically select a broadcast program suitable for the geographical condition of an area surrounding the position of the receiver with reference to a flowchart shown in Fig. 11.

[0097] Like the processing carried out by the first and second embodiments, the automatic program-selection processing represented by the flowchart shown in Fig. 11 is carried out by the system control microcomputer 20 typically when the power supply of the receiver implemented by the third embodiment is turned on to start reception of a DAB ensemble signal or when the front-end unit 2 is operated to change a selected DAB ensemble signal.

[0098] As shown in Fig. 11, the flowchart begins with a step S301 at which the system control microcomputer 20 requests the transmitting-station-identification-information detecting unit 12 to detect transmitting-station identification information of a broadcast station transmitting a demodulated DAB ensemble signal selectively received by the receiver from the null symbol of the signal and to supply the information to the microcomputer 20. Then, the flow of the processing goes on to a step S302 at which the system control microcomputer 20 requests the positional-information detecting unit 13 to detect pieces of positional information (that is, pieces of latitude/longitude information of a plurality of broadcast stations transmitting the modulated DAB ensemble signal selectively received by the receiver) from the FIC of the ensemble signal, and supply the pieces of information to the microcomputer 20.

[0099] The flow of the processing then goes on to a step S303 at which the system control microcomputer 20 uses the transmitting-station identification information supplied thereto by the transmitting-station-identification-information detecting unit 12 to select a particular one among the pieces of latitude/longitude information supplied thereto by the positional-information detecting unit 13. The selected piece of latitude/longitude information can be assumed to be the information on the position of the receiver implemented by the third embodiment, that is, the information on the position of an area in which the transmitting station and the receiver are located.

[0100] The flow of the processing then goes on to a step S304 at which the system control microcomputer 20 uses the selected piece of latitude/longitude information to search the geographical-information data base stored in the geographical-information memory 36 shown in Fig. 9 for a geographical condition of an area surrounding the position of the receiver. The flow of the processing then goes on to a step S305 to form a judgment as to whether or not a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information was found in the search carried out at the step S304. If such a geographical condition was not found, the flow of the processing goes back to the step S304 to repeat the search processing thereof and the formation of a judgment at the step S305 by using another piece of latitude/longitude information. The search processing of the step S304 and the formation of a judgment at the step S305 are repeated till a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information is found.

[0101] As the outcome of the judgment formed at the step S305 indicates that a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information was found in the search carried out at the step S304,

the flow of the processing goes on to a step S306 to search the program-selection data base stored in the program-selection-information memory 37 for a category of a broadcast program to be selected as a first choice for the geographical condition found at the step S304. Then, the FIC information of the DAB ensemble signal received by the receiver is further searched for a broadcast program indicated by the category found in the search of the program-selection data base stored in the program-selection-information memory 37.

[0102] The flow of the processing goes on to a step S307 to form a judgment as to whether or not a broadcast program indicated by the first-choice category associated with the geographical condition was found in the search carried out at the step S306. If a broadcast program indicated by the first-choice category associated with the geographical condition was not found, the flow of the processing goes back to the step S306 to find another category of a broadcast program to be selected as a second choice associated with the same geographical condition. The processing of the step S306 and the formation of a judgment of the step S307 are repeated till a broadcast program indicated by a category associated with the same geographical condition is found. It should be noted that broadcast-program categories are selected as a first choice, a second choice and so on on a priority basis in the same way as the processing represented by the flowchart shown in Fig. 5.

[0103] As the outcome of the judgment formed at the step S307 indicates that a broadcast program to be selected for the geographical condition is found in the search at the step S306, the flow of the processing goes on to a step S308 at which a piece of program-selection information describing the category of a broadcast program to be selected is supplied to the selecting and decoding unit 6. Then, the automatic program-selection processing represented by the flowchart shown in Fig. 11 is ended.

[0104] If the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is urban as shown in Fig. 9, for example, the news category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal as shown in Fig. 10. The news category is then supplied to the selecting and decoding unit 6. Similarly, if the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is suburban as shown in Fig. 9, the classical-music category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal as shown in Fig. 10 and then supplied to the selecting and decoding unit 6. Likewise, if the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is mountainous as shown in Fig. 9, the sport category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal as shown in Fig. 10 and then supplied to the selecting and decoding unit 6.

[0105] Similarly, if the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is a seashore as shown in Fig. 9, the rock-music category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal as shown in Fig. 10 and then supplied to the selecting and decoding unit 6. By the same token, if the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is a plateau as shown in Fig. 9, the popular-music category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal as shown in Fig. 10 and then supplied to the selecting and decoding unit 6.

[0106] As described above, a piece of program-selection information suggesting a category of a broadcast program determined on a priority basis for the geographical condition of an area surrounding the position of the receiver is supplied by the system control microcomputer 20 to the selecting and decoding unit 6 which then selects the broadcast program and extracts the audio data of the selected broadcast program from the demodulated DAB ensemble signal selectively received by the receiver before the audio data is played back and presented to the user.

[0107] Thus, when the user drives an automobile with the DAB receiver of the third embodiment mounted thereon, the user is capable of automatically selecting a desired one among a plurality of broadcast programs multiplexed in a DAB ensemble signal selectively received by the receiver in accordance with the geographical condition of an area surrounding the position of the receiver and listening to the reproduced broadcast program.

Fourth Embodiment

[0108] In a fourth embodiment, a geographical condition of an area surrounding the position of the receiver provided by the third embodiment and a time at which a DAB ensemble signal is received by the receiver as is the case with the second embodiment are taken into consideration in the selection of a broadcast program indicated by a category determined on a priority basis. It should be noted that, since the configuration of the fourth embodiment is shown by the circuit block diagram of Fig. 8 which has been explained in the previous description of the third embodiment, the explanation of the configuration of the fourth embodiment is omitted.

[0109] Fig. 12 is an explanatory diagram used for describing a program-selection data base stored in the program-selection-information memory 37. Program-selection information stored in the program-selection data base is used for determining the category of a broadcast program to be selected as a first choice in accordance with the geographical condition of an area

surrounding the position of the receiver and the reception time.

[0110] As shown in Fig. 12, the program-selection information of the program-selection data base stored in the program-selection-information memory 37 composed of pieces of data each comprising a geographical condition, reception-time information and the category of a broadcast program to be selected as a first choice for the geographical condition and the reception time. A typical value of the reception-time information is either the forenoon (AM) or the afternoon (PM).

[0111] In actuality, for each pair of a geographical condition and a reception-time period, there is provided a list of prioritized broadcast-program categories like the one shown in Fig. 4 to be selected as a first choice, a second choice and so on, on a priority-basis. In Fig.12, however, only the category of a broadcast program to be selected as a first choice is shown for each pair of a geographical condition and a reception-time period.

[0112] If the geographical condition of an area surrounding the position of the receiver is urban and the reception time is a time in the forenoon, for example, the category of a broadcast program to be selected as a first choice is news as shown in Fig. 12. If the geographical condition of an area surrounding the position of the receiver is urban and the reception time is a time in the afternoon, on the other hand, the category of a broadcast program to be selected as a first choice is classical music.

[0113] As described above, the program-selection information of the program-selection data base stored in the program-selection-information memory 37 composed of pieces of data each comprising a geographical condition, reception-time information and the category of a broadcast program to be selected as a first choice with the category varying in dependence on the geographical condition and whether the reception time is an AM or PM time. It is needles to say that the category of a broadcast program to be selected as a first choice for the AM time can be the same as that for the PM time for the same geographical condition as is the case with the suburban condition shown in Fig. 12.

[0114] The program-selection-information memory 37 of a receiver can also be used for storing both the program-selection data base shown in Fig. 10 for the third embodiment and the program-selection data base shown in Fig. 12 for the fourth embodiment. The user of such a receiver is allowed to switch back and forth between processing to automatically select a broadcast program by considering only the geographical condition of an area surrounding the position of the receiver as is the case with the third embodiment and processing to automatically select a broadcast program by considering both the geographical condition of an area surrounding the position of the receiver and the reception time as is the case with the fourth embodiment.

[0115] Typically, such a receiver is provided with a press key for selecting a processing mode on the key-operation unit 31. For example, each time the user of the receiver presses the processing-mode key, the automatic program-selection processing carried out by the receiver is switched from a first processing mode to a second mode or vice versa. Typically, in the first processing mode, a broadcast program is automatically selected by considering both the geographical condition of an area surrounding the position of the receiver and the reception time as is the case with the fourth embodiment. In the second processing mode, on the other hand, a broadcast program is automatically selected by considering only the geographical condition of an area surrounding the position of the receiver as is the case with the third embodiment. Stored in a nonvolatile memory of the system control microcomputer 20, the so-called flag information indicates which processing mode the receiver is currently set in.

[0116] The system control microcomputer 20 carries out automatic program-selection processing by referring to the flag information stored in the nonvolatile memory thereof to select a broadcast program in a processing mode indicated by the flag information.

[0117] Fig. 13 is a flowchart representing automatic program-selection processing carried out by the system control microcomputer 20 employed in a receiver capable of selecting a broadcast program in the first and second processing modes. Like the processing carried out by the first, second and third embodiments, the automatic program-selection processing represented by the flowchart shown in Fig. 13 is carried out by the system control microcomputer 20 typically when the power supply of the receiver is turned on to start reception of a DAB ensemble signal or when the front-end unit 2 is operated to change a selected DAB ensemble signal.

[0118] As shown in Fig. 13, the flowchart begins with a step S401 at which the system control microcomputer 20 refers to the flag information stored in the nonvolatile memory thereof to form a judgment as to whether a broadcast program is to be automatically selected by considering both the geographical condition of an area surrounding the position of the receiver and the reception time or considering only the geographical condition of an area surrounding the position of the receiver.

[0119] If the outcome of the judgment formed at the step S401 indicates that a broadcast program is to be automatically selected without considering the reception time, the flow of the processing goes on to a step S402 to carry out the processing represented by the flowchart shown in Fig. 11 to automatically select a broadcast program by considering only the geographical condition of an area surrounding the position of the receiver by using the program-selection data base shown in Fig. 10. If the outcome of the judgment formed at the step S401 indicates that a broadcast program is to be automatically selected by considering also the reception time, on the other hand, the flow of the processing goes on to a step S403 to carry out the processing represented by a flowchart shown in Fig. 14 to automat-

ically select a broadcast program by considering both the geographical condition of an area surrounding the position of the receiver and the reception time by using the program-selection data base shown in Fig. 12.

[0120] Fig. 14 is a flowchart representing automatic program-selection processing of the step S403 of the flowchart shown in Fig. 13 to automatically select a broadcast program by considering both the geographical condition of an area surrounding the position of the receiver and the reception time by using the program-selection data base shown in Fig. 12. The automatic program-selection processing shown in Fig. 14 is all but the same as the automatic program-selection processing shown in Fig. 11 to automatically select a broadcast program by considering only the geographical condition of an area surrounding the position of the receiver except that, in the case of the processing shown in Fig. 14, a reception time is detected and the program-selection data base shown in Fig. 12 is used in place of the data base shown in Fig. 10.

[0121] As shown in Fig. 14, the flowchart begins with a step S501 at which the system control microcomputer 20 requests the transmitting-station-identification-information detecting unit 12 to detect transmitting-station identification information of a broadcast station transmitting a demodulated DAB ensemble signal received by the receiver from the null symbol of the signal and to supply the information to the microcomputer 20. Then, the flow of the processing goes on to a step S502 at which the system control microcomputer 20 requests the positional-information detecting unit 13 to detect pieces of positional information (that is, pieces of latitude/longitude information of a plurality of broadcast stations transmitting the modulated DAB ensemble signal detected by the receiver) from the FIC of the ensemble signal, and supply the pieces of information to the microcomputer 20.

[0122] The flow of the processing then goes on to a step S503 at which the system control microcomputer 20 uses the transmitting-station-identification information supplied thereto by the transmitting-station-identification-information detecting unit 12 to select a particular one among the pieces of latitude/longitude information supplied thereto by the positional-information detecting unit 13. The selected piece of latitude/longitude information is assumed to be the information on the position of the receiver implemented by the fourth embodiment, that is, the information on the position of an area in which the transmitting station and the receiver are located.

[0123] The flow of the processing then goes on to a step S504 at which the system control microcomputer 20 uses the selected piece of latitude/longitude information to search the geographical-information data base stored in the geographical-information memory 36 shown in Fig. 9 for a geographical condition of an area surrounding the position of the receiver. The flow of the processing then goes on to a step S505 to form a judgment as to whether or not a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information was found in the search carried out at the step S504. If such a geographical condition was not found, the flow of the processing goes back to the step S504 to repeat the search processing thereof by using another piece of latitude/longitude information and the formation of a judgment at the step S505. The search processing of the step S504 and the formation of a judgment at the step S505 are repeated till a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information is found like the steps S304 and S305 of the flowchart shown in Fig 11. As the outcome of the judgment formed at the step S505 indicates that a geographical condition of an area surrounding the position of the receiver associated with the selected piece of latitude/longitude information was found in the search carried out at the step S504, the flow of the processing goes on to a step S506 to obtain a reception time from the timer circuit 32.

[0124] The flow of the processing then goes on to a step S507 to search the program-selection data base stored in the program-selection-information memory 37 shown in Fig. 12 for a category of a broadcast program to be selected as a first choice associated with the geographical condition found at the step S504 and the reception time obtained at the step S506. Then, the FIC information of the DAB ensemble signal received by the receiver is further searched for a broadcast program indicated by the category found in the search of the program-selection data base stored in the program-selection-information memory 37.

[0125] The flow of the processing goes on to a step S508 to form a judgment as to whether or not a broadcast program indicated by the first-choice category associated with the geographical condition found at the step S504 and the reception time found at the step S506 was found in the search carried out at the step S507. If a broadcast program indicated by first-choice category associated with the geographical condition and the reception time was not found, the flow of the processing goes back to the step S507 to find another category of a broadcast program to be selected as a second choice associated with the latitude/longitude information and the reception time. The processing of the step S507 and the formation of a judgment of the step S508 are repeated till a broadcast program indicated by a category associated with the geographical condition and the reception time is found. It should be noted that broadcast-program categories are selected as a first choice, a second choice and so on, on a priority basis in the same way as the processing represented by the flowchart shown in Fig. 5.

[0126] As the outcome of the judgment formed at the step S508 indicates that a category of a broadcast program to be selected for the geographical condition and the reception time is found in the search at the step

S507, the flow of the processing goes on to a step S509 at which a piece of program-selection information describing the category of a broadcast program to be selected is supplied to the selecting and decoding unit 6. Then, the automatic program-selection processing represented by the flowchart shown in Fig. 14 is ended.

[0127] If the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is urban and the reception time is a time in the forenoon, the news category is determined for a broadcast program to be automatically selected as a first choice from the demodulated DAB ensemble signal, as shown in Fig. 12. The news category is then supplied to the selecting and decoding unit 6. Similarly, if the detected latitude/longitude information indicates that the geographical condition of an area surrounding the position of the receiver is urban and the reception time is a time in the afternoon, the classical-music category is determined for a broadcast program to be selected as a first choice from the demodulated DAB ensemble signal and then supplied to the selecting and decoding unit 6. In this way, a broadcast program to be selected as a first choice is automatically chosen on the basis of the geographical condition of an area surrounding the position of the receiver and the reception time.

[0128] Thus, when the user drives an automobile with the DAB receiver of the third (or fourth) embodiment mounted thereon, the user is capable of automatically selecting a desired one among a plurality of broadcast programs multiplexed in a DAB ensemble signal selectively received by the receiver in accordance with the geographical condition of an area surrounding the position of the receiver (and the reception time) and listening to the reproduced broadcast program.

[0129] In the first to fourth embodiments described above, a broadcast program is selected automatically when reception of DAB ensemble signals is started or when a broadcast station from which a DAB ensemble signal is received is changed. It should be noted, however, that a broadcast program can also be selected automatically in accordance with the geographical condition of an area surrounding the position of the receiver, the reception time or both the geographical condition of an area surrounding the position of the receiver and the reception time at predetermined intervals such as travel distances or periods of travel time determined in advance.

[0130] As another alternative, a broadcast program can also be selected automatically at predetermined intervals described above as well as at times transmitting-station-identification information different from just preceding transmitting-station-identification information is newly detected in accordance with the geographical condition of an area surrounding the position of the receiver, the reception time or both the geographical condition of an area surrounding the position of the receiver and the reception time.

Changing the Program-Selection Data Base

[0131] In the receivers implemented by the first to fourth embodiments described above, the user is capable of changing program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37.

[0132] To put it in detail, when the user of the receiver operates an operation key of the key operation unit 31 of the receiver to request a change in program-selection information, processing to change the program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37 is carried out.

[0133] Fig. 15 is a flowchart representing processing to change the program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37. The processing represented by the flowchart shown in Fig. 15 is carried out by the system control microcomputer 20 at predetermined intervals.

[0134] As shown in Fig. 15, the flowchart begins with a step S601 at which the system control microcomputer 20 forms a judgment as to whether or not the user has entered a request for a change in program-selection information via the key operation unit 31. If the outcome of the judgment formed at the step S601 indicates that there is no request for a change in program-selection information, the processing represented by the flowchart shown in Fig. 15 is ended without doing anything.

[0135] If the outcome of the judgment formed at the step S601 indicates that there is a request for a change in program-selection information, on the other hand, the flow of the processing goes on to a step S602 at which the system control microcomputer 20 displays the program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37 on the LCD device 34 by way of the LCD controller 33.

[0136] The flow of the processing then proceeds to a step S603 at which the user of the receiver enters a change in program-selection information via a group of operation keys of the operation key unit 31 while referring to the program-selection information of the program-selection data base displayed on the LCD device 34. The system control microcomputer 20 then receives the change in program-selection information entered by the user and uses the change in program-selection information to modify the program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37.

[0137] As a result, in the case of the receiver implemented by the first embodiment, the priority order of categories of broadcast programs to be selected stored in the program-selection-information memory 35 shown in Fig. 4 can be changed. In the case of the receiver implemented by the second embodiment in which a list of broadcast-program categories is stored for each recep-

tion-time period in the program-selection-information memory 35 shown in Fig. 6, the range of a reception-time period or the priority order of the list for a reception-time period can be changed. It should be noted, however, that Fig. 6 shows only the category of a broadcast program to be selected as the first choice instead of a list of broadcast-program categories for each reception-time period.

[0138] In the case of the receiver implemented by the third embodiment in which a list of broadcast-program categories is stored for each geographical condition in the program-selection-information memory 37 shown in Fig. 10, the description of a geographical condition or the priority order of the list for a geographical condition can be changed. It should be noted, however, that Fig. 10 shows only the category of a broadcast program to be selected as the first choice instead of a list of broadcast-program categories for each geographical condition.

[0139] In the case of the receiver implemented by the fourth embodiment in which a list of broadcast-program categories is stored for each pair of a geographical condition and a reception time in the program-selection-information memory 37 shown in Fig. 12, the description of a pair of a geographical condition and a reception-time period or the priority order of the list for such a pair can be changed. It should be noted, however, that Fig. 12 shows only the category of a broadcast program to be selected as the first choice instead of a list of broadcast-program categories for each pair of a geographical condition and a reception-time period.

[0140] In this way, the user of the receiver is capable of changing a broadcast program to be selected as a first choice with a high degree of freedom as the user likes and letting the receiver select a broadcast program automatically as the user desires.

Automatic and Manual Program Selection

[0141] In addition, the receivers implemented by the first to fourth embodiments described above are each not only capable of automatically selecting a broadcast program by using program-selection information of the program-selection data base stored in the program-selection-information memory 35 or 37, but also capable of selecting a broadcast program by using program-selection information entered by the user of the receivers. That is to say, the receivers implemented by the first to fourth embodiments described above are each provided with automatic and manual program-selection modes which can be switched from one to another by the user.

[0142] The automatic and manual program-selection modes are switched from one to another typically when the user presses a program-selection-mode switching button of the key operation unit 31. Information on the program-selection mode which can be changed by the user is stored in a nonvolatile memory of the system control microcomputer 20.

[0143] The system control microcomputer 20 refers to the information stored in the nonvolatile memory thereof to form a judgment as to whether a broadcast program is to be selected in the automatic or manual program-selection mode.

[0144] Fig. 16 is a flowchart representing processing carried out by the system control microcomputer 20 to select a broadcast program in the automatic or manual program-selection mode. The processing is carried out by the system control microcomputer 20 when reception of DAB ensemble signals is started or when a broadcast station from which a DAB ensemble signal is received is changed.

[0145] As shown in Fig. 16, the flowchart begins with a step S701 at which the system control microcomputer 20 refers to the information stored in the nonvolatile memory thereof to form a judgment as to whether a broadcast program is to be selected in the automatic or manual program-selection mode.

[0146] If the outcome of the judgment formed at the step S701 indicates that a broadcast program is to be selected in the automatic program-selection mode, the flow of the processing goes on to a step S702 at which a broadcast program is selected in the automatic program-selection mode from a DAB ensemble signal on the basis of program-selection information read out from the program-selection data base stored in the program-selection-information memory 35 or 37. The processing represented by the flowchart shown in Fig. 16 is then ended. Thus, the step S702 represents the automatic program-selection processing represented by the flowchart shown in Fig. 11, 13 or 14.

[0147] If the outcome of the judgment formed at the step S701 indicates that a broadcast program is to be selected in the manual program-selection mode, on the other hand, the flow of the processing goes on to a step S703 at which the system control microcomputer 20 receives program-selection information entered by the user via the key operation unit 31. Then, the flow of the processing continues to a step S704 at which the input program-selection information entered by the user is supplied to the selecting and decoding unit 6 which then extracts a broadcast program indicated by the program-selection information from a DAB ensemble signal prior to operations to play back the audio data of the extracted broadcast program and present reproduced audio data to the user.

[0148] In this way, the receivers implemented by the first to fourth embodiments allow proper use of the automatic and manual program-selection modes as follows. When an automobile with a receiver of any one of the first to fourth embodiments mounted thereon is parked at a parking lot or when a person who is not a driver in the automobile operates the receiver, for example, the user is allowed to set the receiver in the manual program-selection mode by changing the information stored in the nonvolatile memory to the manual program-selection mode and operate the key operation unit

31 to select a desired broadcast program.

[0149] As an alternative, the receiver is set in the automatic program-selection mode all the time till the user enters a command to select a broadcast program manually by operating the key operation unit 31. At that time, a list of selectable broadcast programs is displayed and the user is allowed to select a broadcast program from the list.

Detection of the Precise Position of the Receiver

[0150] In the receivers implemented by the third and fourth embodiments, an approximate position of the receiver or a reception range is identified as one of positions of transmitting stations included in a DAB ensemble signal which is identified by an identification of a broadcast station transmitting the DAB ensemble signal. The identified position is then used in a search of the geographical-information data base stored in the geographical-information memory 36 for a geographical condition of an area surrounding the position of the receiver.

[0151] As described above, in the case of the DAB system, a plurality of broadcast stations each for transmitting a small-power broadcast signal are laid out to form a broadcasting network and the receiver is capable of receiving DAB ensemble signals having the same frequency from the transmitting broadcast stations.

[0152] Fig. 17 is an explanatory diagram used for describing a relation between locations of DAB transmitting stations and the position of the receiver. As shown in the figure, in the DAB system, a plurality of broadcast stations transmit small-power broadcast signals at the same frequency. Thus, in the example shown in Fig. 17, the receiver is capable of receiving broadcast signals at the same frequency from a plurality of transmitting broadcast stations at locations in close proximity to the receiver, namely, transmitting stations ST1, ST2 and ST3.

[0153] In this case, the receiver's reception timing of a DAB ensemble signal transmitted by a broadcast station is different from the receiver's reception timing of a DAB ensemble signal transmitted by any other broadcast station even if the signals are conveyed by carriers having the same frequency. By detecting differences in phase among DAB ensemble signals transmitted by different broadcast stations, the precise location of the receiver can be determined.

[0154] In order to determine the precise position of the receiver, the synchronization processor 5 employed in the receivers implemented by the third and fourth embodiments detects phase shifts among received signals and supplies the detected phase shifts to the system control microcomputer 20. That is to say, the synchronization processor 5 functions as a phase-shift detecting means.

[0155] The system control microcomputer 20 then determines the position of the receiver by using typically a 3-point measurement technique based on phase shifts among DAB ensemble signals transmitted by a plurality of broadcast stations supplied thereto by the synchronization processor 5 and pieces of information on the locations of the broadcast stations. Thus, in this case, the system control microcomputer 20 functions as a reception-position detecting means for determining the position of the receiver from phase shifts among DAB ensemble signals transmitted by a plurality of broadcast stations and pieces of information on the locations of the transmitting broadcast stations.

[0156] In this way, the position of the receiver can be detected with a high degree of accuracy. Geographical areas on a map are classified by condition into cities and suburbs, and information associating each area with a geographical condition such as a city and a suburb is stored in the geographical-information memory 36 as a geographical-information data base. Thus, a precise position of the receiver can be used to identify the geographical condition of an area surrounding the position with a high degree of accuracy. Each geographical condition is associated with a list of prioritized categories of broadcast programs and a category on the list is used for automatically selecting a broadcast program from a DAB ensemble signal.

[0157] In the case of the receivers implemented by the first to fourth embodiments described above, the user is capable of determining whether a broadcast program is to be selected by considering both the reception time and the geographical condition of an area surrounding the position of the receiver or considering only the geographical condition of an area surrounding the position of the receiver and capable of setting either an automatic or manual program-selection mode by operating the so-called direct keys such as a processing-mode switching button and a program-selection-mode switching button of the key operation unit 31. It should be noted, however, that ways to determine a processing mode and a program-selection mode are not limited to what are described above.

[0158] For example, a menu display key can be operated to display a list of pieces of executable processing on the LCD device 34. By selecting a desired piece of processing from the list, the user is then capable of carrying out any of various kinds of processing such as setting a variety of modes and changing information stored in the program-selection-information memory 37.

[0159] In addition, in the third and fourth embodiments described above, the geographical-information memory 36 and the program-selection-information memory 37 are provided for storing the geographical-information data base and the program-selection data base respectively. It should be noted that the geographical-information data base and the program-selection data base can of course be stored in the same memory. By creating the geographical-information data base and the program-selection data base separately, however, the amount of information can be reduced.

[0160] Moreover, in the third and fourth embodiments described above, a program-selection data base associating the category of a broadcast program to be selected with a geographical condition as shown in Fig. 10 and a program-selection data base associating the category of a broadcast program to be selected with a pair of a geographical condition and a reception time as shown in Fig. 12 are both stored in the program-selection-information memory 37. It should be noted, however, that implementations of the present invention are not limited to such a scheme. For example, the 2 program-selection data bases are stored in separate memories and one of the memories is accessed in dependence of whether the automatic program-selection processing is based on a geographical condition only or both a geographical condition and a reception time.

[0161] Furthermore, in the embodiments described above, the program-selection-information memory 35 or 37 and the geographical-information memory 36 are provided independently of each other. It is worth noting, however, that implementations of the present invention are not limited to such a scheme. For example, the data bases for storing information used to be stored in the program-selection-information memory 35 or 37 and the geographical-information memory 36 can also be created and stored in a memory existing from the beginning or a memory also used in other processing such as a nonvolatile incorporated in the system control microcomputer 20.

[0162] On the top of that, the embodiments provided by the present invention as described above are each applied to a receiver mounted on a vehicle. It should be noted, however, that applications of the present invention are not limited to a receiver mounted on a vehicle. For example, the present invention can also be applied to a receiver that can be carried by the user such as a portable receiver. It is needless to say that the present invention can also be applied to a set-type receiver for home applications.

[0163] In addition, the embodiments provided by the present invention as described above are each applied to a DAB receiver. It is worth noting, however, that applications of the present invention are not limited to a DAB receiver. For example, the present invention can also be applied to a variety of other DAB receivers as long as the receivers are used for receiving broadcast signals each conveying a plurality of broadcast programs multiplexed therein and additional information used for identifying the broadcast programs.

[0164] As described above, according to a DAB receiver as in claim 1, a broadcast program to be listened to by the user is automatically selected from a plurality of broadcast programs multiplexed in a DAB ensemble signal on a priority basis in accordance with program-selection information stored in a program-selection-information storage unit. As a result, it is no longer necessary for the user to carry out a complex operation to select a desired one among a plurality of broadcast programs.

[0165] In addition, according to a DAB receiver as in claim 2, a broadcast program to be listened to by the user is automatically selected on a priority basis in accordance with a geographical condition of an area surrounding the position of the receiver.

[0166] Moreover, according to a DAB receiver as in claim 3, a broadcast program to be listened to by the user is automatically selected on a priority basis in accordance with a reception time without the need for the user to carry out a complicated operation to select a broadcast program. For example, a broadcast program of traffic information, popular music or classical music is selected at a commutation time, a time in the afternoon or a time on a way to home respectively.

[0167] Furthermore, according to a DAB receiver as in claim 4, a broadcast program to be listened to by the user is automatically selected on a priority basis in accordance with a reception time and a geographical condition.

[0168] On the top of that, according to a DAB receiver as in claim 5, the position of the receiver is detected with a high degree of accuracy, making it possible to automatically select a broadcast program to be listened to by the user from a plurality of broadcast programs multiplexed in a DAB ensemble signal on a priority basis in accordance with a geographical condition of an area surrounding the position of the receiver which is determined correctly by the accurate position of the receiver.

Claims

1. A digital-audio-broadcast receiver with a configuration comprising:

   a tuner for selectively receiving a digital-audio-broadcast ensemble signal conveying a plurality of broadcast programs multiplexed therein and additional identification information revealing contents of each of said broadcast programs;
   a program-selection-information storage unit for storing program-selection information suggesting a broadcast program to be selected on a priority basis from said broadcast programs multiplexed in said digital-audio-broadcast ensemble signal; and
   a program selecting unit for extracting a broadcast program from said digital-audio-broadcast ensemble signal selectively received by said tuner in accordance with said program-selection information stored in said program-selection-information storage unit and said additional identification information conveyed by said digital-audio-broadcast ensemble signal.

2. A digital-audio-broadcast receiver according to

claim 1 further comprising:

a positional-information detecting means for detecting positional information added to said digital-audio-broadcast ensemble signal and used for showing a position of a broadcast station transmitting said digital-audio-broadcast ensemble signal;
a reception-position detecting means for detecting a position of reception of said digital-audio-broadcast ensemble signal on the basis of a detection result output by said positional-information detecting means;
a geographical-information storage unit for storing geographical conditions each associated with a position; and
a geographical-condition detecting means for searching said geographical-information storage unit for said geographical condition associated with a position detected by said reception-position detecting means as a reception position,
wherein
said program-selection information stored in said program-selection-information storage unit associates each of said geographical conditions with a broadcast program to be selected on a priority basis; and
a broadcast program extracted by said program selecting unit from said digital-audio-broadcast ensemble signal is associated by said program-selection information stored in said program-selection-information storage unit with said geographical condition detected by said geographical-condition detecting means as well as identified by said additional identification information included in said digital-audio-broadcast ensemble signal.

3. A digital-audio-broadcast receiver according to claim 1 or 2, further comprising a present-time detecting means for detecting a present time to receive said digital-audio-broadcast ensemble signal

wherein
said program-selection information stored in said program-selection-information storage unit associates each of pieces of information on time with a broadcast program to be selected on a priority basis; and
a broadcast program extracted by said program selecting unit from said digital-audio-broadcast ensemble signal is associated by said program-selection information stored in said program-selection-information storage unit with a piece of information on time detected by said present-time detecting means as a present time as well as identified by said additional identification information included in said digital-audio-broadcast ensemble signal.

4. A digital-audio-broadcast receiver according to any one of the preceding claims further comprising:

a positional-information detecting means for detecting positional information added to said digital-audio-broadcast ensemble signal and used for showing a position of a broadcast station transmitting said digital-audio-broadcast ensemble signal;
a reception-position detecting means for detecting a position of reception of said digital-audio-broadcast ensemble signal on the basis of a detection result output by said positional-information detecting means;
a geographical-information storage unit for storing geographical conditions each associated with a position;
a geographical-condition detecting means for searching said geographical-information storage unit for said geographical condition associated with a position detected by said reception-position detecting means as a reception position; and
a present-time detecting means for detecting a present time to receive said digital-audio-broadcast ensemble signal,
wherein
said program-selection information stored in said program-selection-information storage unit comprises pairs which are each composed of one of said geographical conditions and a piece of information on time and each associated with a broadcast program to be selected on a priority basis; and
a broadcast program extracted by said program selecting unit from said digital-audio-broadcast ensemble signal is identified by said additional identification information included in said digital-audio-broadcast ensemble signal as well as associated with one of said pairs in said program-selection information stored in said program-selection-information storage unit composed of said geographical condition detected by said geographical-condition detecting means and a piece of information on time detected by said present-time detecting means as a present time.

5. A digital-audio-broadcast receiver according to claim 2 or 4, or any claim appendant thereto further comprising a phase-shift detecting means for detecting phase shifts among a plurality of said digital-audio-broadcast ensemble signals transmitted by the same plurality of broadcast stations using carriers having the same frequency, selectively re-

ceived by said tuner, wherein said reception-position detecting means detects said position of reception from positional information detected by said positional-information detecting means and phase shifts detected by said phase-shift detecting means.

6. A digital-audio-broadcast receiver according to any one of hte preceding claims further comprising:

a change-request-input receiving means for receiving a request for a change to be made to said program-selection information stored in said program-selection-information storage unit; and
an information changing means for changing said program-selection information stored in said program-selection-information storage unit in accordance with said request for a change input by said change-request inputting means.

7. A digital-audio-broadcast receiver for receiving a digital-audio-broadcast ensemble signal conveying a plurality of broadcast programs multiplexed therein and additional identification information revealing contents of each of said broadcast programs and for automatically selecting one of said broadcast programs multiplexed in said digital-audio-broadcast ensemble signal in an automatic selection mode or manually selecting one of said broadcast programs multiplexed in said digital-audio-broadcast ensemble signal in a manual selection mode in accordance with a request issued by the user, said digital-audio-broadcast receiver comprising:

a tuner for selectively receiving a digital-audio-broadcast ensemble signal conveying a plurality of broadcast programs multiplexed therein;
a program selecting unit for extracting a broadcast program from said digital-audio-broadcast ensemble signal selectively received by said tuner;
a program-selection-information storage unit for storing program-selection information suggesting a broadcast program to be selected on a priority basis from said broadcast programs multiplexed in said digital-audio-broadcast ensemble signal;
a selection-indicating-information receiving means for receiving an input of selection indicating information entered by the user for selecting a broadcast program;
a selection-information receiving means for receiving an input of information for selecting a mode entered by the user; and
a mode switching means for setting said automatic selection mode or said manual selection mode in accordance with information for selecting a mode received by said selection-information receiving means,
wherein
said program selecting unit extracts a broadcast program from said digital-audio-broadcast ensemble signal selectively received by said tuner in accordance with said program-selection information stored in said program-selection-information storage unit and said additional identification information conveyed by said digital-audio-broadcast ensemble signal in said automatic selection mode set by said mode switching means; and
said program selecting unit extracts a broadcast program from said digital-audio-broadcast ensemble signal selectively received by said tuner in accordance with an input of selection indicating information entered by the user via said selection-indicating-information receiving means and said additional identification information conveyed by said digital-audio-broadcast ensemble signal in said manual selection mode set by said mode switching means.

FIG. 1

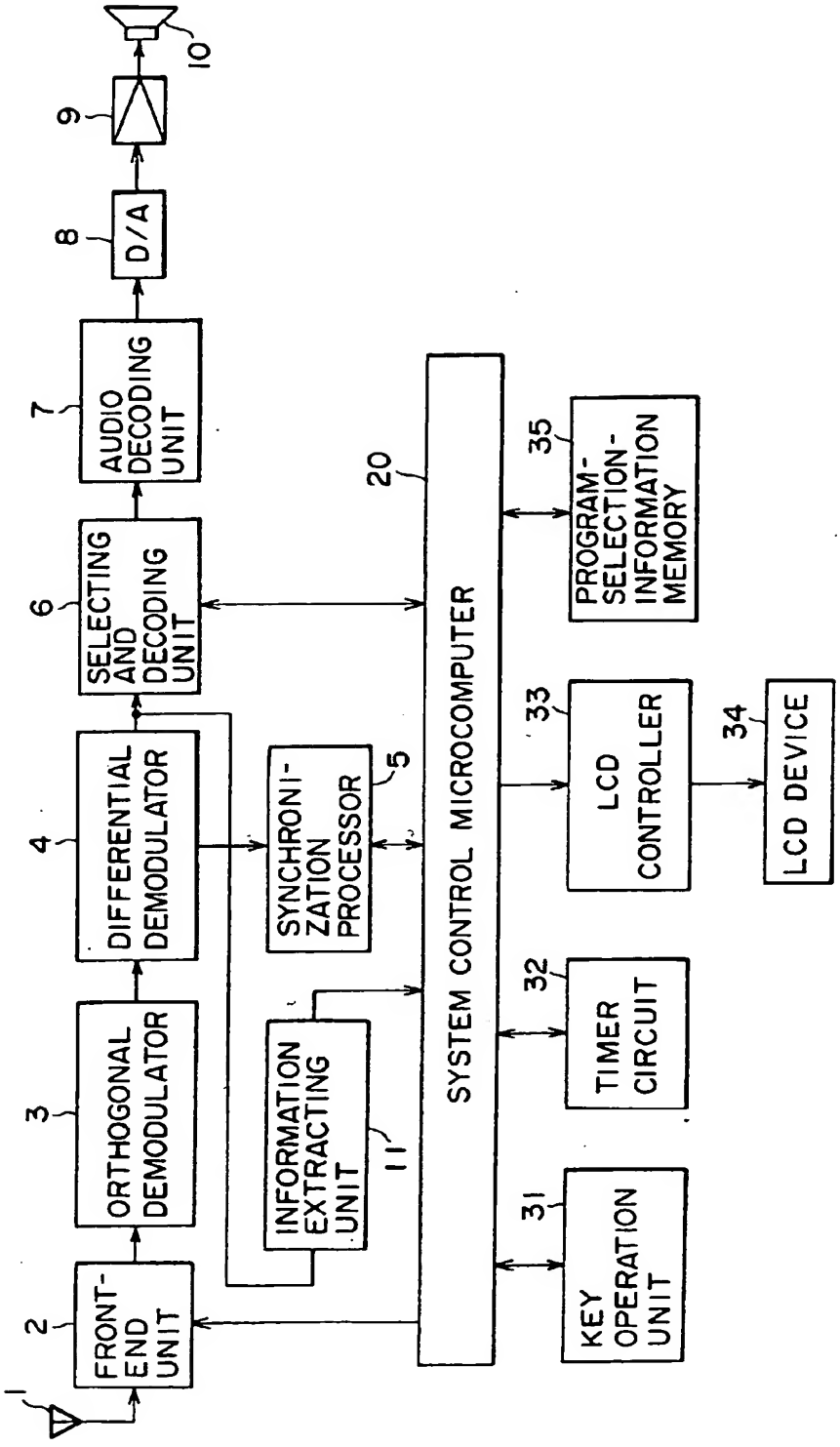

1
2
FRONT-END UNIT
3
ORTHOGONAL DEMODULATOR
4
DIFFERENTIAL DEMODULATOR
5
SYNCHRONIZATION PROCESSOR
6
SELECTING AND DECODING UNIT
7
AUDIO DECODING UNIT
8
D/A
9
10
11
INFORMATION EXTRACTING UNIT
20
SYSTEM CONTROL MICROCOMPUTER
31
KEY OPERATION UNIT
32
TIMER CIRCUIT
33
LCD CONTROLLER
34
LCD DEVICE
35
PROGRAM-SELECTION-INFORMATION MEMORY

FIG. 2

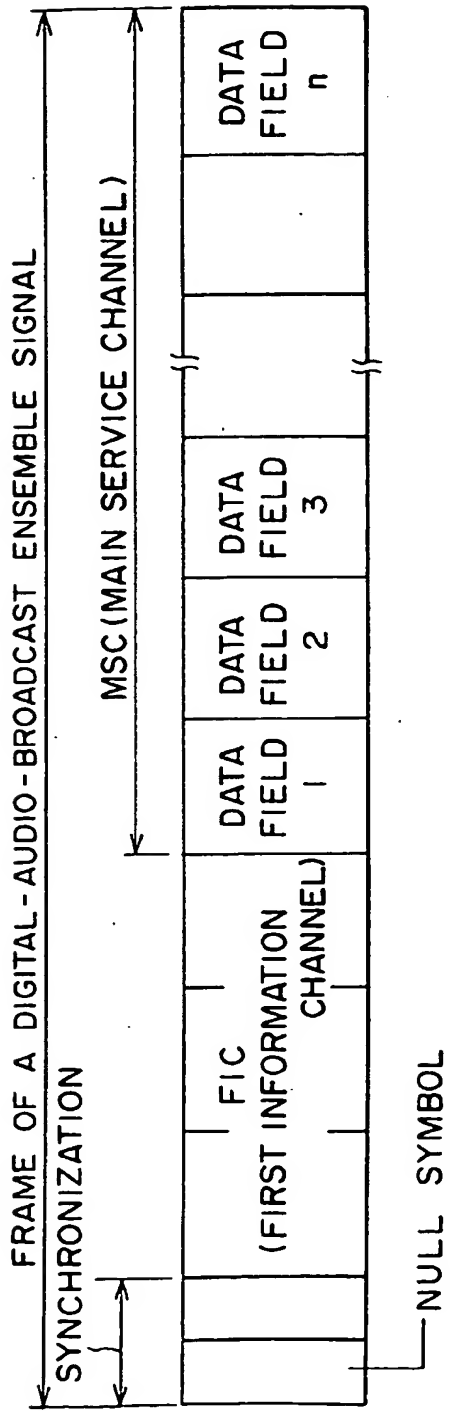

FRAME OF A DIGITAL-AUDIO-BROADCAST ENSEMBLE SIGNAL
SYNCHRONIZATION
FIC (FIRST INFORMATION CHANNEL)
MSC (MAIN SERVICE CHANNEL)
DATA FIELD 1
DATA FIELD 2
DATA FIELD 3
DATA FIELD n
NULL SYMBOL

FIG. 3

DIGITAL-AUDIO-BROADCAST ENSEMBLE SIGNAL

CONVEYED PROGRAMS	PROGRAM CATEGORY
PROGRAM 1	NEWS
PROGRAM 2	SPORT
PROGRAM 3	POPULAR MUSIC
PROGRAM 4	CLASSICAL MUSIC
PROGRAM 5	ROCK MUSIC

FIG. 4

PROGRAM-SELECTION-INFORMATION MEMORY

PRIORITY LEVEL	PRIORITIZED PROGRAM CATEGORY
1	NEWS
2	CLASSICAL MUSIC
3	POPULAR MUSIC
⋮	⋮

FIG. 5

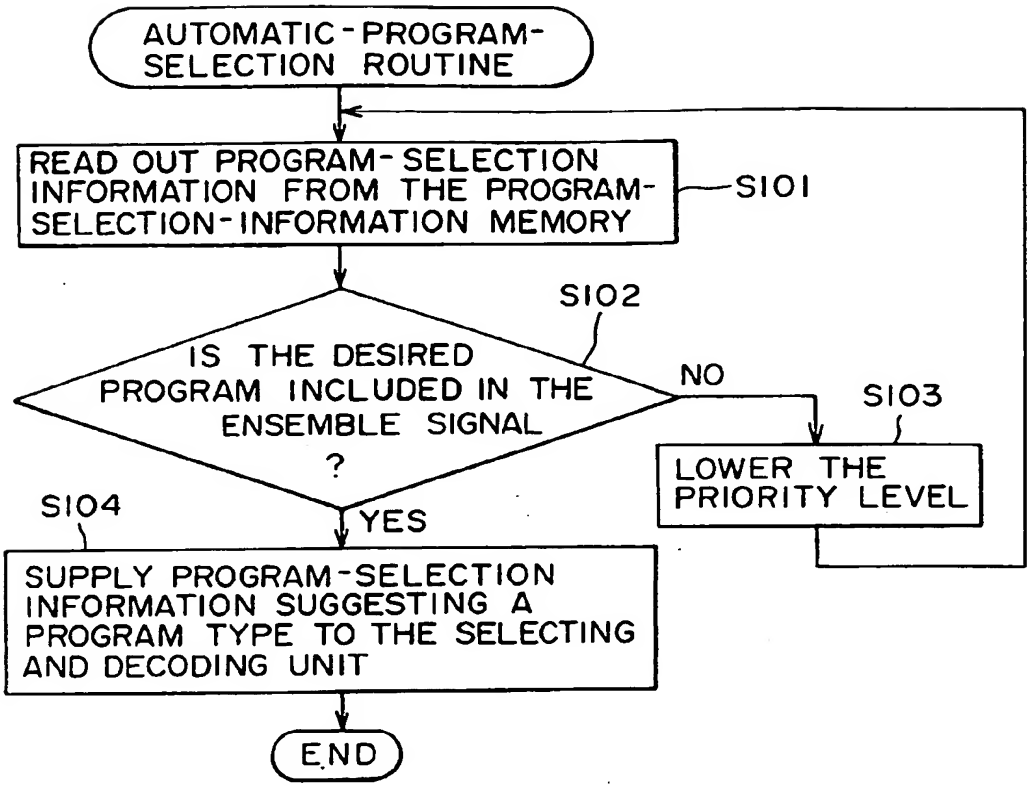


FIG. 6

PROGRAM-SELECTION-INFORMATION MEMORY 35

PERIOD OF TIME	CATEGORY OF A FIRST-CHOICE PROGRAM
6:00~9:00	TRAFFIC INFORMATION
9:00~17:00	POPULAR MUSIC
17:00~19:00	NEWS
AFTER 19:00	CLASSICAL MUSIC

FIG. 7

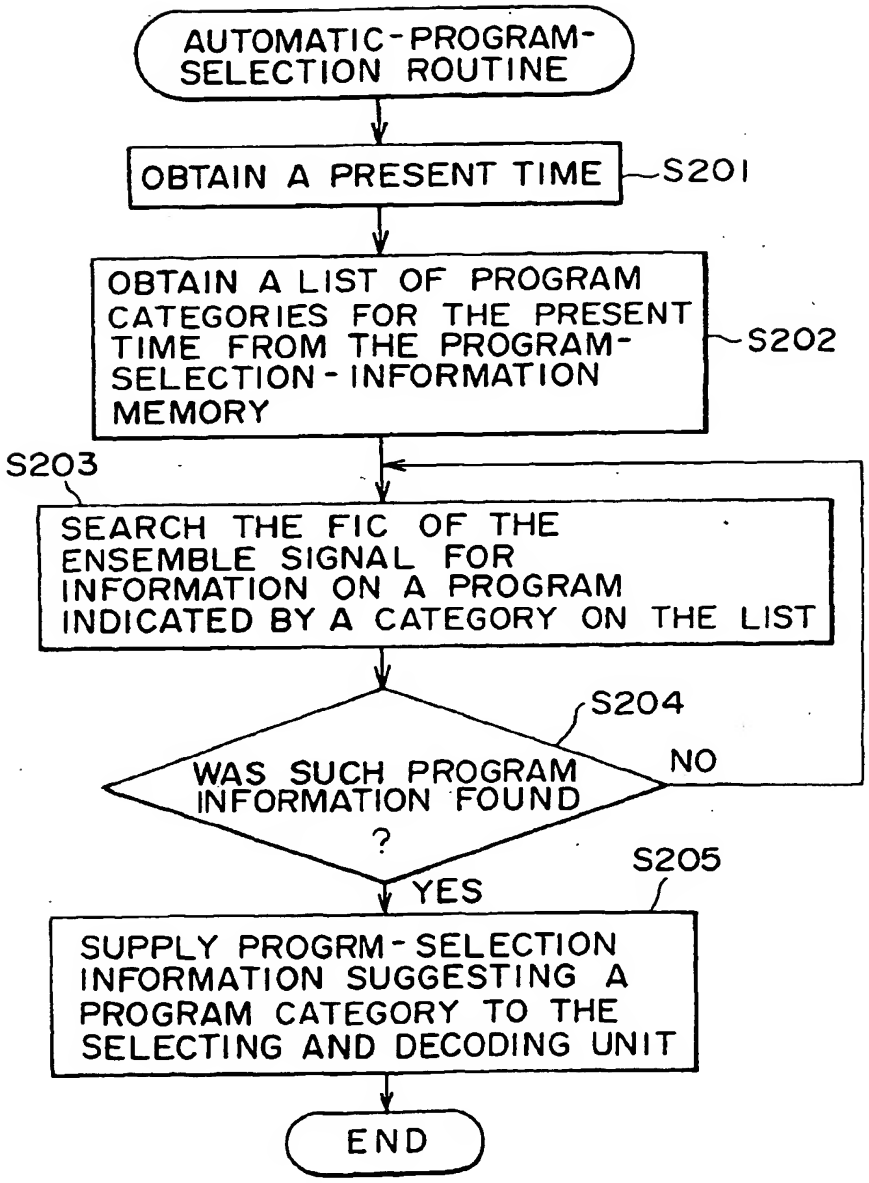

AUTOMATIC-PROGRAM-SELECTION ROUTINE
OBTAIN A PRESENT TIME
S201
OBTAIN A LIST OF PROGRAM CATEGORIES FOR THE PRESENT TIME FROM THE PROGRAM-SELECTION-INFORMATION MEMORY
S202
S203
SEARCH THE FIC OF THE ENSEMBLE SIGNAL FOR INFORMATION ON A PROGRAM INDICATED BY A CATEGORY ON THE LIST
S204
WAS SUCH PROGRAM INFORMATION FOUND ?
NO
YES
S205
SUPPLY PROGRM-SELECTION INFORMATION SUGGESTING A PROGRAM CATEGORY TO THE SELECTING AND DECODING UNIT
END

FIG. 8

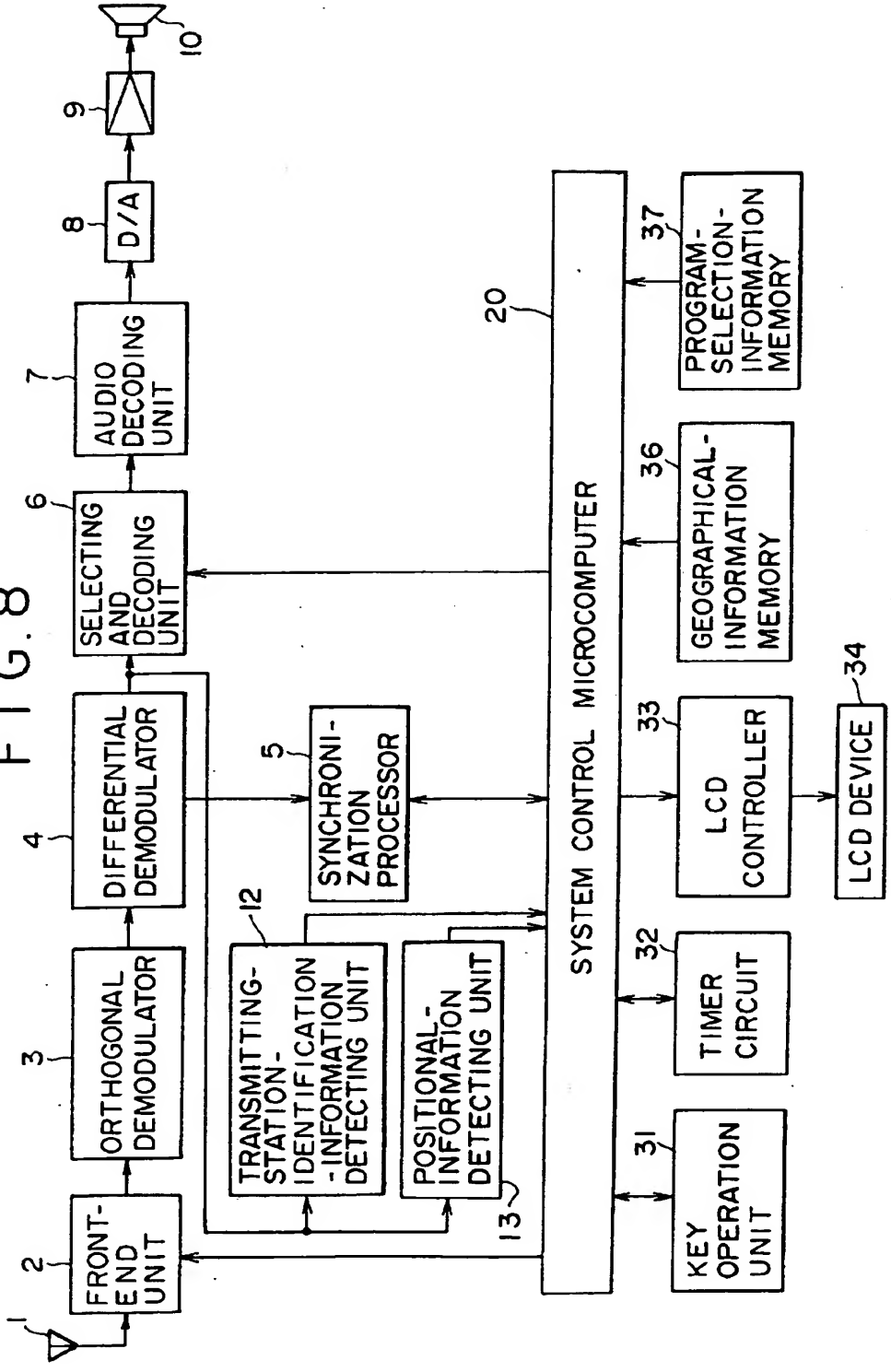

1
2
FRONT-END UNIT
3
ORTHOGONAL DEMODULATOR
4
DIFFERENTIAL DEMODULATOR
5
SYNCHRONIZATION PROCESSOR
6
SELECTING AND DECODING UNIT
7
AUDIO DECODING UNIT
8
D/A
9
10
12
TRANSMITTING-STATION-IDENTIFICATION-INFORMATION DETECTING UNIT
13
POSITIONAL-INFORMATION DETECTING UNIT
20
SYSTEM CONTROL MICROCOMPUTER
31
KEY OPERATION UNIT
32
TIMER CIRCUIT
33
LCD CONTROLLER
34
LCD DEVICE
36
GEOGRAPHICAL-INFORMATION MEMORY
37
PROGRAM-SELECTION-INFORMATION MEMORY

FIG. 9

GEOGRAPHICAL-INFORMATION MEMORY 36

GEOGRAPHICAL-INFORMATION DATA BASE	
POSITIONAL INFORMATION	GEOGRAPHICAL CONDITION
LATITUDE/LONGITUDE	URBAN AREA
LATITUDE/LONGITUDE	SUBURB
LATITUDE/LONGITUDE	MOUNTAIN
LATITUDE/LONGITUDE	SEASHORE
LATITUDE/LONGITUDE	PLATEAU

FIG. 10

PROGRAM-SELECTION-INFORMATION MEMORY 37

PROGRAM-SELECTION DATA BASE	
GEOGRAPHICAL CONDITION	CATEGORY OF A FIRST-CHOICE PROGRAM
URBAN AREA	NEWS
SUBURB	CLASSICAL MUSIC
MOUNTAIN	SPORT
SEASHORE	ROCK MUSIC
PLATEAU	POPULAR MUSIC

FIG. 11

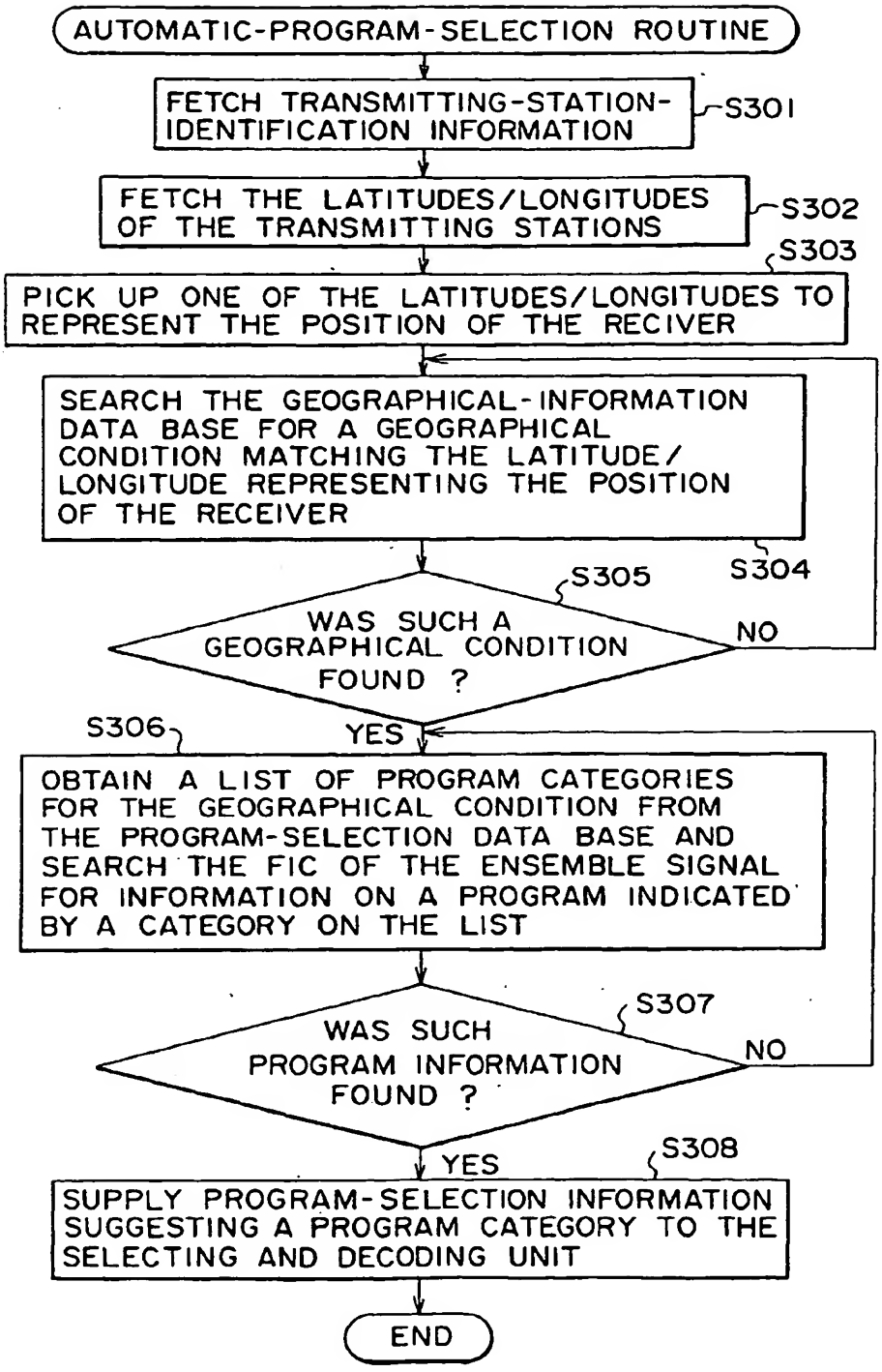

AUTOMATIC-PROGRAM-SELECTION ROUTINE
FETCH TRANSMITTING-STATION-IDENTIFICATION INFORMATION
S301
FETCH THE LATITUDES/LONGITUDES OF THE TRANSMITTING STATIONS
S302
S303
PICK UP ONE OF THE LATITUDES/LONGITUDES TO REPRESENT THE POSITION OF THE RECIVER
SEARCH THE GEOGRAPHICAL-INFORMATION DATA BASE FOR A GEOGRAPHICAL CONDITION MATCHING THE LATITUDE/LONGITUDE REPRESENTING THE POSITION OF THE RECEIVER
S304
S305
WAS SUCH A GEOGRAPHICAL CONDITION FOUND ?
NO
YES
S306
OBTAIN A LIST OF PROGRAM CATEGORIES FOR THE GEOGRAPHICAL CONDITION FROM THE PROGRAM-SELECTION DATA BASE AND SEARCH THE FIC OF THE ENSEMBLE SIGNAL FOR INFORMATION ON A PROGRAM INDICATED BY A CATEGORY ON THE LIST
S307
WAS SUCH PROGRAM INFORMATION FOUND ?
NO
YES
S308
SUPPLY PROGRAM-SELECTION INFORMATION SUGGESTING A PROGRAM CATEGORY TO THE SELECTING AND DECODING UNIT
END

FIG. 12

PROGRAM-SELECTION-INFORMATION MEMORY 37

PROGRAM-SELECTION DATA BASE		
URBAN AREA	AM	NEWS
	PM	CLASSICAL MUSIC
SUBURB	AM	CLASSICAL MUSIC
	PM	CLASSICAL MUSIC
MOUNTAIN	AM	WEATHER FORECAST
	PM	SPORT
SEASHORE	AM	WEATHER FORECAST
	PM	ROCK MUSIC
PLATEAU	AM	CLASSICAL MUSIC
	PM	POPULAR MUSIC

FIG. 13

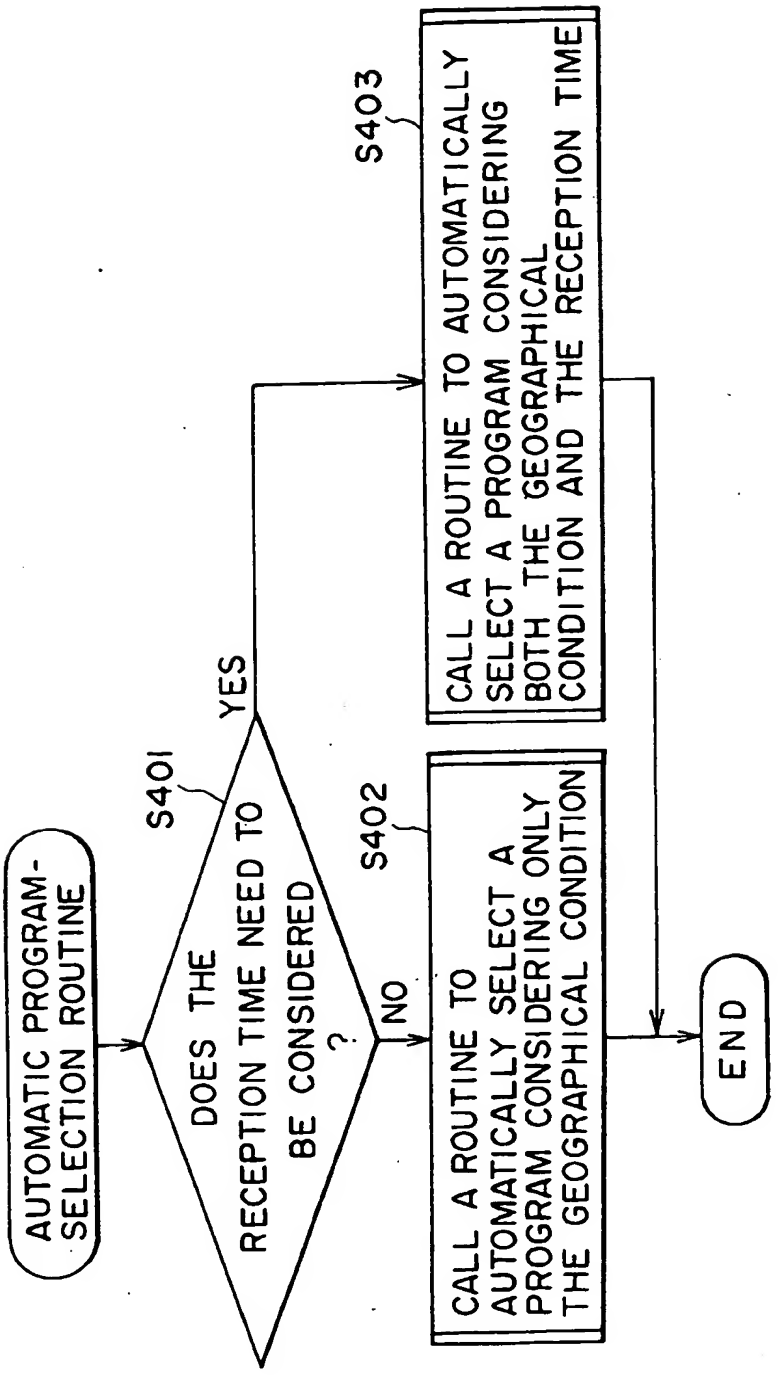

AUTOMATIC PROGRAM-SELECTION ROUTINE
S401
DOES THE RECEPTION TIME NEED TO BE CONSIDERED ?
YES
NO
S402
CALL A ROUTINE TO AUTOMATICALLY SELECT A PROGRAM CONSIDERING ONLY THE GEOGRAPHICAL CONDITION
S403
CALL A ROUTINE TO AUTOMATICALLY SELECT A PROGRAM CONSIDERING BOTH THE GEOGRAPHICAL CONDITION AND THE RECEPTION TIME
END

FIG. 14

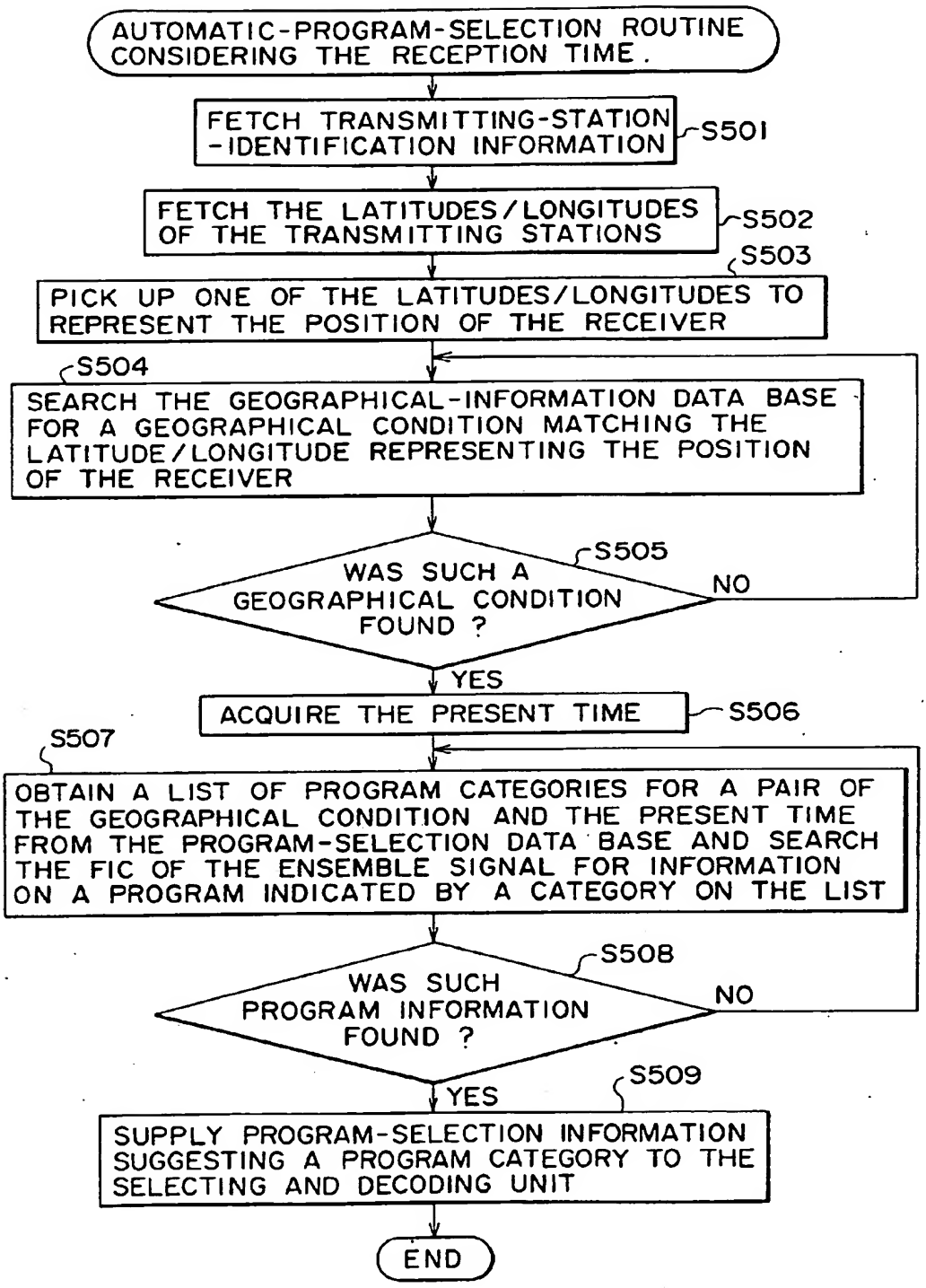

AUTOMATIC-PROGRAM-SELECTION ROUTINE CONSIDERING THE RECEPTION TIME.
FETCH TRANSMITTING-STATION -IDENTIFICATION INFORMATION
S501
FETCH THE LATITUDES/LONGITUDES OF THE TRANSMITTING STATIONS
S502
S503
PICK UP ONE OF THE LATITUDES/LONGITUDES TO REPRESENT THE POSITION OF THE RECEIVER
S504
SEARCH THE GEOGRAPHICAL-INFORMATION DATA BASE FOR A GEOGRAPHICAL CONDITION MATCHING THE LATITUDE/LONGITUDE REPRESENTING THE POSITION OF THE RECEIVER
S505
WAS SUCH A GEOGRAPHICAL CONDITION FOUND ?
NO
YES
ACQUIRE THE PRESENT TIME
S506
S507
OBTAIN A LIST OF PROGRAM CATEGORIES FOR A PAIR OF THE GEOGRAPHICAL CONDITION AND THE PRESENT TIME FROM THE PROGRAM-SELECTION DATA BASE AND SEARCH THE FIC OF THE ENSEMBLE SIGNAL FOR INFORMATION ON A PROGRAM INDICATED BY A CATEGORY ON THE LIST
S508
WAS SUCH PROGRAM INFORMATION FOUND ?
NO
YES
S509
SUPPLY PROGRAM-SELECTION INFORMATION SUGGESTING A PROGRAM CATEGORY TO THE SELECTING AND DECODING UNIT
END

FIG. 15

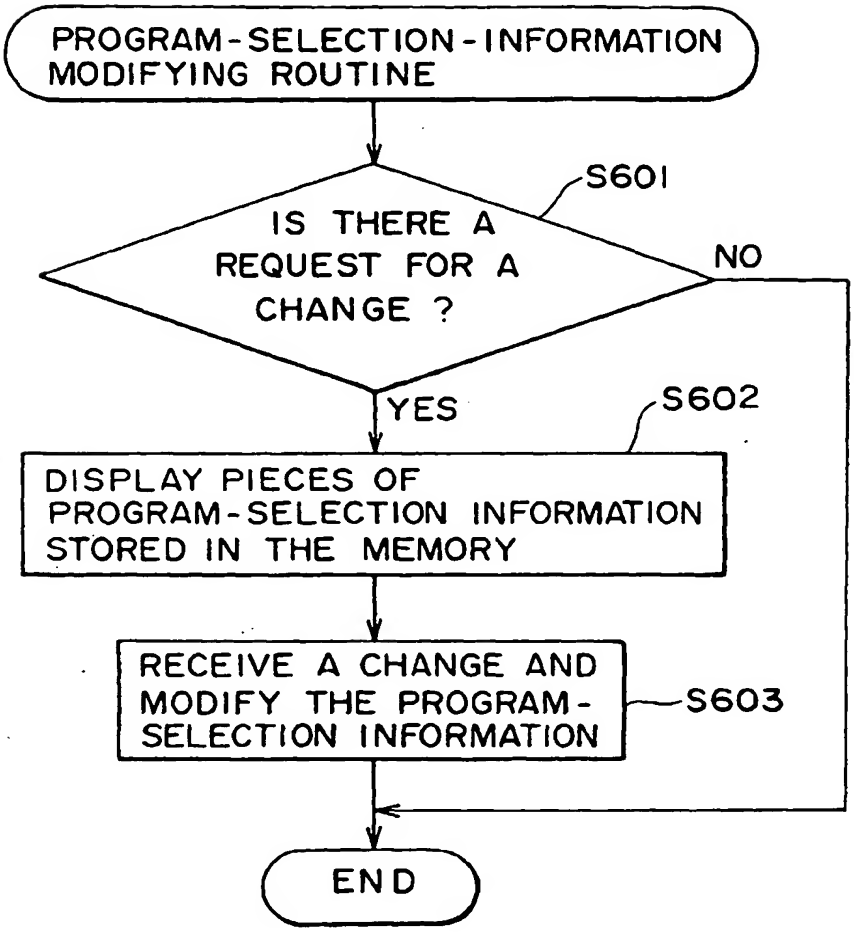

PROGRAM-SELECTION-INFORMATION MODIFYING ROUTINE
S601
IS THERE A REQUEST FOR A CHANGE ?
NO
YES
S602
DISPLAY PIECES OF PROGRAM-SELECTION INFORMATION STORED IN THE MEMORY
RECEIVE A CHANGE AND MODIFY THE PROGRAM-SELECTION INFORMATION
S603
END

FIG. 16

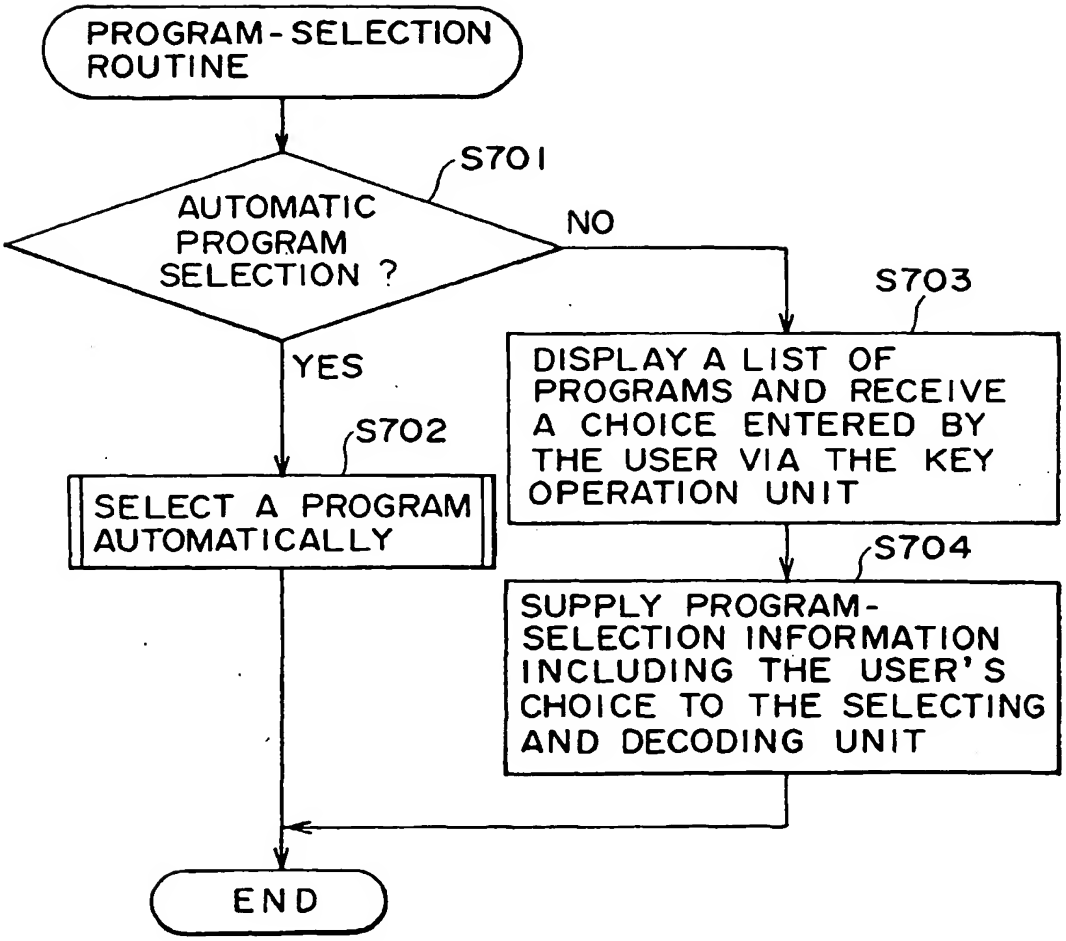
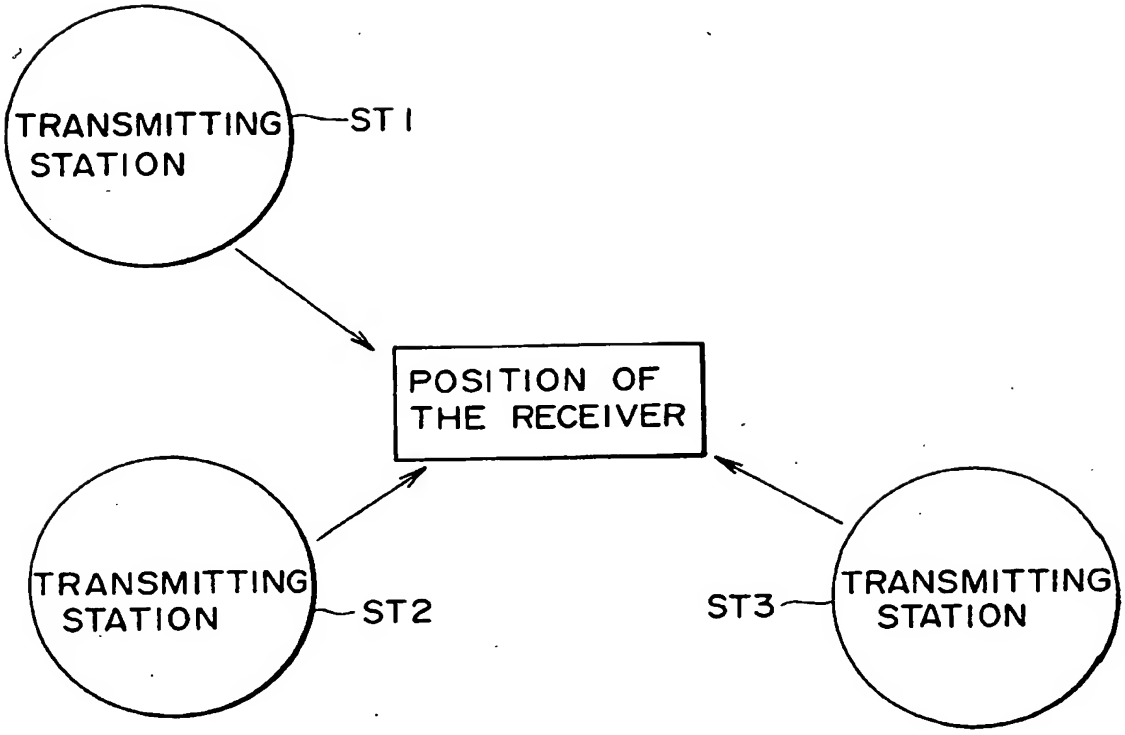

PROGRAM-SELECTION ROUTINE
S701
AUTOMATIC PROGRAM SELECTION ?
NO
YES
S702
SELECT A PROGRAM AUTOMATICALLY
S703
DISPLAY A LIST OF PROGRAMS AND RECEIVE A CHOICE ENTERED BY THE USER VIA THE KEY OPERATION UNIT
S704
SUPPLY PROGRAM-SELECTION INFORMATION INCLUDING THE USER'S CHOICE TO THE SELECTING AND DECODING UNIT
END

FIG. 17


TRANSMITTING STATION
ST 1
POSITION OF THE RECEIVER
TRANSMITTING STATION
ST2
ST3
TRANSMITTING STATION